UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

June 11, 2003

MEMORANDUM

Subject: EFED Revised Risk Assessment for the Reregistration Eligibility Decision of Oxadiazon (PC Code 109001)

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This memo provides a summary of the EFED Environmental Risk Assessment for the Oxadiazon Reregistration Eligibility Document (RED). Oxadiazon is registered for use on terrestrial non-food crop sites, including golf courses, landscape (turf and ornamentals), nurseries, and roadside areas. Based on laboratory and field data, oxadiazon is a persistent, lipophilic compound that has a low mobility in most soils, and may be susceptible to aqueous photolysis. Oxadiazon is also a light-dependent peroxidizing herbicide (LDPH) that has the potential for the induction of phototoxicity.

Our risk assessment shows that oxadiazon use has the potential for chronic exposure to aquatic organisms that could result in reproductive effects to estuarine/marine fish and aquatic invertebrates. Other aquatic issues of concern include oxidiazon's ability to bind and accumulate in the sediment thus resulting in possible toxic exposure to aquatic organisms that live in or near the benthos. Since oxadiazon exposure to light has the potential for free radical generation, phototoxicity may be another issue of toxic concern for aquatic organisms.

Acute exposure of oxadiazon (emulsifiable concentrate and granular) to birds and mammals should not present short term toxic risk. However, the potential for chronic risk to mammals and birds may result in reproductive effects.

EFED also has a concern that acute exposure of oxadiazon to aquatic and terrestrial systems may result in the potential for risk to endangered species that include mammals, birds, fish and aquatic invertebrates. Since this compound is a herbicide, there can be an assumption of potential risk to nontarget plants (terrestrial, semi-aquatic and aquatic). The studies that have been submitted show that this compound is potentially a toxic risk to aquatic vascular and nonvascular plants. However, this possible risk to nontarget terrestrial plants cannot be fully assessed at this time due to the lack of acceptable data.

Outstanding Data Requirements

Environmental Fate:

Although the environmental fate data base is largely complete, EFED will require the following additional study:

162-4 Aerobic Aquatic Metabolism

Ecological Effects:

72-4 (a) Early-Life Stage Estuarine Fish

72-4 (b) Life Cycle Estuarine Invertebrate

123-1 Seedling Emergence and Vegetative Vigor- using a liquid TEP to represent both granular and liquid formulations (note in the case that liquid formulations are not supported for reregistration, only seedling emergence testing would be required; vegetative vigor testing is not required for granular formulations)

70-1 Acute and Chronic Sediment Toxicity Testing - Oxadiazon shows a high K_{OC}, combined with a high persistence exhibited in the aerobic soil metabolism, and the anaerobic aquatic metabolism (>10 days). These fate properties indicate that there may be risk to benthic-dwelling aquatic invertebrates, however the potential for risk cannot be assessed until data have been submitted. The Chronic Sediment Toxicity Testing data requirement is triggered, with *Chironomus tentans* and the Acute Chronic Sediment Toxicity Testing data requirement is triggered, with both Hyalella azteca, and *Chironomus tentans*.

70-1 Phototoxicity studies on fathead minnow. A subchronic exposure duration would be adequate for proof of concept. Behavioral observations should be conducted in addition to mortality, growth, and morphology. All studies should be conducted under defined light conditions (refer to rebuttal memo June 6, 2003).

Endangered Species

The Agency has developed the Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that address these impacts. The Endangered Species Act requires federal agencies to ensure that their actions are not likely to jeopardize listed species or adversely modify designated critical habitat. To analyze the potential of registered pesticide uses to affect any particular species, EPA puts basic toxicity and exposure data developed for REDs into context for individual listed species and their locations by evaluating important ecological parameters, pesticide use information, the geographic relationship between specific pesticide uses and species locations, and biological requirements and behavioral aspects of the particular species. This analysis will take into consideration any regulatory changes recommended in this RED that are being implemented at this time. A determination that there is a likelihood of potential impact to a listed species may result in limitations on use of the pesticide, other measures to mitigate any potential impact, or consultations with the Fish and Wildlife Service and/or the National Marine Fisheries Service as necessary.

The Endangered Species Protection Program as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989) is currently being implemented on an interim basis. As part of the interim program, the Agency has developed County Specific Pamphlets that articulate many of the specific measures outlined in the Biological Opinions issued to date. The Pamphlets are available for voluntary use by pesticide applicators on EPA's website at www.epa.gov/espp. A final Endangered Species Protection Program, which may be altered from the interim program, is scheduled to be proposed for public comment in the Federal Register before the end of 2001.

Endocrine Disruption

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow,

screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, oxadiazon, may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption. Issues that have raised this concern include fish reproduction effects (larval and embryo survival, egg hatchability) and invertebrate reproduction effects (reduced neonate production) also suggest endocrine disruption.

Uncertainties

Environmental Fate and Exposure:

There is some uncertainty in using the FIRST and GENEEC2 models respectively for drinking water and aquatic assessment. These two models are typically used for Tier I screening purposes for pesticides applied to soils. In turf environments, the fate characteristics and transport behavior of oxadiazon may be different than those in soils. Whether the difference is significant is not known at the present. Hence, it is difficult to estimate the magnitude of uncertainty. The turf scenario for PRZM/EMAMS Tier II modeling is not available at this time so turf EECs can not be further refined..

Ecological Effects:

Since oxadiazon is a herbicide, there is a potential for risk to nontarget plants. Lack of adequate data represents an uncertainty with regards to the risk, which may be further clarified through the submission of data.

In the absence of data on chronic effects of oxadiazon to estuarine aquatic organisms, chronic testing results from freshwater fish and invertebrates species were extrapolated, representing an uncertainty which may be satisfied through the submission of appropriate data.

The high persistence and lipophilicity of this chemical and its likelihood to accumulate in the sediment suggest that there may be risk to benthic and epibenthic aquatic life (fish and aquatic invertebrates). However the potential for risk cannot be further refined until additional data (sediment toxicity tests) have been submitted.

Enhanced toxicity of oxadiazon to aquatic organisms after light exposure is an uncertainty. The inhibition of protoporphyrinogen oxidase, the rapid accumulation of protoporphyrin IX with the resulting generation of singlet oxygen (free radicals)and eventual cell membrane destruction suggest that exposure to this compound may increase toxicity to aquatic organisms.

Label Recommendations:

EFED recommends that the labels for all oxadiazon products carry the following statements:

Environmental Hazards

i. Manufacturing Use Product:

This pesticide is toxic to fish and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. For guidance, contact your State Water Board or Regional Office of the EPA.

ii. End-Use Product:

This pesticide is toxic to fish and aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Do not apply when weather conditions favor drift from treated areas. Runoff and drift from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not allow this product to drift.

SUPPLEMENT

Possible Risk Mitigation Measures:

To reduce risk to plants and aquatic organisms, possible risk mitigation measures may include, but are not limited to:

- The addition of a well maintained buffer zone can also mitigate the risk. It is known that buffer zones can decrease the amount of spray drift reaching bodies of water.

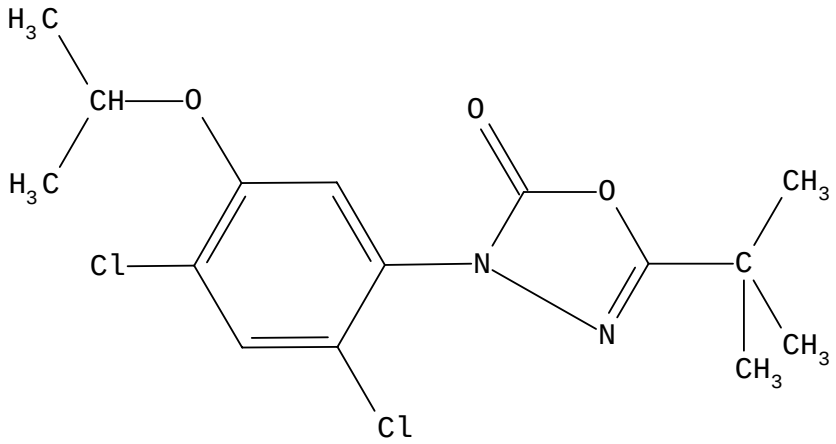
- The current label suggests that to improve the efficacy, prior to application, the turf should be mowed and after application it should be irrigated if rain is not expected shortly. Making this suggestion compulsory would assure that most of the chemical reaches the soil surface, where it is less prone to runoff.

Environmental Fate and Ecological Risk Assessment
for the Reregistration Eligibility Decision

Oxadiazon; Ronstar®

2-tert-Butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-delta^2-1,3,4-oxadiazoline-5-one and 3-[2,4-Dichloro-5-(1-methylethoxy)phenyl]-5-(1,1-dimethyl-ethyl)-1,3,4-oxadiazol-2(3H)-one

Shaughnessy Number: 109001
CAS Number: 19666-30-9



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CHAPTER 1: ENVIRONMENTAL RISK CONCLUSIONS

a. Registered Uses

Oxadiazon is a selective pre-emergent and early post-emergent herbicide used to control grassy and broadleaf weeds in turf and ornamentals. Application rates range from 2 to 4 lbs ai/A, with usually only one application made per season. Most of the products are in granular form. The herbicide's primary use is on golf courses, turf farms and ornamental plantings. The registrant, Aventis, is supporting a maximum yearly use of eight pounds of active ingredient per acre. Aerial applications are not being supported (SRRD communication).

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Table 1. Oxadiazon Registered Use on Turf (Golf Courses), Nursery and Roadsides.

Usage	Maximum Application Rate (lbs ai/A)	Number of Applications	Minimum Application Interval (days)	Maximum Application Rate per Season (lbs ai/A)
Turf (Ground Spray)	4.0	2	182	8.0
	4.0	1	NA	4.0
	3.0	1	NA	3.0
	2.0	1	NA	2.0
Turf (Ground Spray) Split Application	1.0	8	42	8.0
	1.3	6	56	8.0
Turf (Granular)	4.0	2	182	8.0
	4.0	1	NA	4.0
	3.0	1	NA	3.0
	2.0	1	NA	2.0

b. Major Risk Concerns

Our assessment shows that oxadiazon exposure in the aquatic environment can present significant chronic risk to freshwater fish and aquatic invertebrates. The chronic Level of Concern (LOC) was exceeded by up to 132-fold for fish and 37-fold for aquatic invertebrates. Although this Tier I risk assessment suggests that acute exposure of oxadiazon to aquatic systems should result in relatively lower short term risk to non endangered fish and aquatic invertebrates there is uncertainty regarding possible phototoxicity. Since oxadiazon is an LDPH compound, enhanced toxicity through exposure to high levels of solar radiation is a possible concern that could impact aquatic organisms that inhabit small, shallow water bodies. Oxadiazon is also a lipophilic compound that has the capacity to strongly bind to particulates and organic carbon. This binding can result in accumulation in the sediment raising concerns for toxic risk to benthic and epibenthic aquatic organisms (aquatic insects, amphipods, crustaceans, mollusks, bivalves,

etc). Since sediment act as a reservoir for lipophilic persistent compounds, sediment bound oxadiazon presents a high risk potential for aquatic life because of direct contact with various organisms through respiration, ingestion, dermal contact, or indirectly through alterations of the food chain. The herbicidal properties of this compound also strongly suggest that there is a potential for toxic risk to aquatic plants (monocots and dicots) which may result in an indirect impact on aquatic systems through habitat alteration. Endangered species concerns have also been triggered for fish, aquatic invertebrates and plants.

Terrestrial exposure of this compound to mammals and birds can result in potential chronic risk while the acute risk to terrestrial organisms (birds, mammals, and honey bees) from the registered use of oxadiazon appears low. However, information on the herbicidal mode of action of oxadiazon strongly suggests that there is a potential for acute risk to nontarget aquatic and terrestrial plants. The limited plant data for oxadiazon shows that this compound can present a toxic risk to nontarget plants (EC_{25} values reported in the seedling emergence/vegetative vigor tests were as low as about a tenth of a pound per acre). Although there does not appear to be an acute risk to endangered birds and mammals there may be chronic concerns as reflected in the two-fold LOC exceedences for non endangered terrestrial animals. Therefore, our assessment suggests that endangered terrestrial species (birds, mammals, and terrestrial plants) may be at risk.

c. Oxadiazon Incident History

There are no confirmed incidents associated with the use of oxadiazon in the Environmental Fate and Effects Division EIIS Database. However, this data base is compiled through voluntary submissions that may only capture a small fraction of actual incidents.

d. Likelihood of Water Contamination

The potential impact to water quality from the use of oxadiazon on turf is essentially due to the parent (as opposed to possible degradates). Oxadiazon appears to be very persistent under most environmental conditions making the chemical available for surface runoff. Moreover, the remaining important factor which affects the impact of oxadiazon on water quality is its mobility. A soil column leaching study, and supplemental batch equilibrium studies indicated that oxadiazon has low mobility in the various soils tested. Ordinarily this would mean that the chemical would remain soil bound and would be transported to a water body on eroded soil. Turf scenarios, however, offer different challenges than other conventional crops. The turf itself offers a vegetative interception layer (including thatch) that prevents rapid deposition of the oxadiazon on the surface of the soil. Both liquid and granular formulations labels of oxadiazon specify that the chemical's effectiveness is improved if it is wetted in after application. Furthermore, both labels recommend mowing the grass prior to application. Oxadiazon is expected to bind to soil particles, but turf scenarios offer vegetation interception.

The models used for the determination of the water exposures were FIRST, GENEEC 2.0 for surface waters, and SCIGROW for ground waters. The models are screening models designed to provide upper-bound estimates of the concentrations that might be found due to the use of oxadiazon. For drinking water worst case scenario (4 lb a.i./A applied at 6-months interval) was used. Further refinements of our

computer models were not possible at this time. The EFED is currently developing a turf scenario, which is expected to be ready in the near future. Surface water monitoring data for oxadiazon is very limited and cannot be used to represent possible concentrations of oxadiazon in surface waters. The chemical is not included in the NAWQA monitoring studies. The STORET database contained only two samples taken from the same location within an interval of only four days. The estimated recommended acute, and long term drinking water concentrations are detailed in Chapter 6.

Oxadiazon has a high affinity to soils and sediments $K_{OC} \approx 2357$, combined with the high persistence exhibited in the aerobic soil metabolism (>>1year), as well as the anaerobic aquatic metabolism (≈ 1 year studies). It appeared that oxadiazon would be a persistent chemical in sediment environments.

Although oxadiazon exhibits high affinity to soils and a relatively high bioconcentration factor (K_{ow} = 63100; BCF's of 368X, 2239X, and 1111X for muscle, viscera, and whole fish, respectively), the rate of depuration was relatively rapid (half-life of about one day).

e. Recommended Drinking Water Concentrations for HED

As per HED's request, the drinking water assessment for oxadiazon is as follows: the peak untreated surface water concentration is **246** ppb, and the annual average untreated water concentration is **100** ppb . These values represent upper-bound estimates of the concentrations of oxadiazon that might be found in surface water due to the use of oxadiazon on turf at the maximum application rate of 8.0 lb a.i./A/season. **The recommended oxadiazon ground water concentration is 0.6 ppb**.

f. Monitoring and Modeling

As shown in Table 3, the groundwater concentration estimated from SCIGROW is 0.6 ppb which is about two orders of magnitude lower than those of surface water. This concentration may be used for both acute and chronic values. The low concentration is consistent with both laboratory and field studies that indicate the low mobility of oxadiazon, and subsequently, its **reduced potential to reach groundwater.**

CHAPTER 2: INTRODUCTION

a. Mode of Action

Oxadiazon is a selective pre-emergent and early post-emergent herbicide used to control grassy weeds (*e.g.*, crabgrass and goosegrass) and broadleaf weeds. The primary mode of action of oxadiazon is inhibition of protoporphyrinogen oxidase (Protex), a critical enzyme in the biosynthesis of chlorophyll and heme (Matringe *et al.*, 1989). Consistent with protoporphyrinogen oxidase- inhibiting herbicides, tissue exposed in darkness accumulate protoporphyrin IX, which can lead to a photodynamic loss of cell membrane integrity (free radical development) upon exposure to light.

b. Use Characterization

The formulation types include granular (39 products; predominant formulation), wettable powder (2 products), soluble concentrate (1 product) and emulsifiable concentrate (1 product). Aventis is the sole technical registrant. Oxadiazon is registered for use on terrestrial non-food crop sites, including golf courses; landscape (turf and ornamentals); nursery; and roadside.

An annual estimate of oxadiazon's total usage is 249,000 pounds of active ingredient on 52,000 acres. Most of the use is on golf courses, which accounts for about 77% of all use. Application rates range from two to four pounds active ingredient per acre. According to SRRD, Aventis is supporting a maximum application of 4.0 lb ai/A per six month period, equivalent to 8.0 lbs ai/year and aerial applications are not being supported. Since efficacy (pre emergent control)is based on oxadiazon reaching and remaining in the soil, product labels may specify to mow, if necessary, before application, and to irrigate, if rain is not expected shortly. Oxadiazon may also be used for early post-emergent control, but this is to a much lesser extent. (usage information was obtained from BEAD's Qualitative Use Assessment, Appendix K).

Oxadiazon is classified as an oxadiazole herbicide. The chemical name is: 5-tert-Butyl-3-(2,4-dichloro-5-isopropoxyphenyl)-1,3,4-oxadiazol-2(3H)-one. Other chemical names are: (IUPAC). 2-tert-Butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-delta^2-1,3,4-oxadiazoline-5-one and 3-[2,4-Dichloro-5-(1-methylethoxy)phenyl]-5-(1,1-dimethyl-ethyl)-1,3,4-oxadiazol-2(3H)-one. Trade names include Ronstar, RP-17623, and G 315.

c. Approach to Risk Assessment

In order to conduct an ecological risk assessments on this compound, EFED used dosage rate information obtained from SRRD and BEAD. The evaluation of the potential risk to aquatic and terrestrial organisms from the use of oxadiazon, was assessed through the calculation of risk quotients (RQs) that were derived from the ratio of estimated environmental concentrations (EECs) to ecotoxicity values (see Appendix F). EECs were based on the maximum and typical application rate of oxadiazon to turf. These RQs are then compared to the Levels of Concern (LOC) (Appendix F) criteria used by EFED for determining potential risk to nontarget organisms and the subsequent need for possible regulatory action.

Terrestrial exposure was evaluated using EECs generated from ELL-FATE spreadsheet-based model that calculates the decay of a chemical applied to foliar surfaces for single and multiple applications. The model assumes initial concentrations on plant surfaces based on Kenaga predicted maximum residues as modified by Fletcher *et al.* (1994) and assumes 1st order dissipation. Kenaga estimates and an explanation of the model with sample output are presented in Appendix F. In the absence of foliar dissipation half-life data for oxadiazon a 35-day half-life was used. The selection of this half-life was based on the upper limit of pesticide, foliar dissipation half-lives provided in the half-life listing of Willis and McDowell, 1987. EFED uses this value as a default equivalent when the foliar dissipation for a particular pesticide is unknown or in question[1]. The terrestrial and aquatic risk assessment was also based on the three maximum application rates of 4.0, 3.0, and 2.0 lbs ai/A at 2 applications each and a 4.0 lbs ai/A for granular, at 2 applications. Additional exposure scenarios for split application (1.0 and 1.3 lbs ai/A, at 6 and 8 week intervals, respectively) were conducted for terrestrial exposure.Aquatic exposure was evaluated using EECs generated from the Tier I GENEEC2 model.

[1]EFED examined two DER's that provide data (2-7 day half-life) on the decay of transferable residues of oxadiazon from turf surfaces to a cotton cloth, EFED chose not to use these studies because one study was conducted on a granular formulation and the other study presented a quantitative concern.

Aquatic and terrestrial risk assessments were conducted by using worst case ecotoxicity endpoints (*i.e.*, LD50 and LC50 values, NOAEC values). The toxicity endpoints chosen for use in the ecological risk assessment are summarized below.

Table 2. Selection of Toxicological Endpoints Used to Determine Risk Quotients (RQs)

Type Of Toxicity	Organism	Species	Toxicological Endpoint
Oral Acute	Bird	mallard	1040 mg/kg
Dietary		bobwhite/mallard	>5000 ppm
Chronic		bobwhite	500 ppm [1]
Oral Acute	Mammal	rat	>5000 mg/kg
Chronic		rat	200 ppm [2]
Acute	Freshwater Fish	rainbow trout/bluegill	0.88 ppm
Chronic		rainbow trout	0.88 ppb [3]
Acute	Freshwater Invertebrates	daphnid	2.18 ppm
Chronic		daphnid	0.03 ppm
Acute	Estuarine Fish	sheepshead minnow	1.5 ppm
Chronic		sheepshead minnow	0.0015 ppm [4]
Acute	Estuarine Invertebrates	mysid	0.27 ppm
Chronic		mysid	0.0037ppm[4]
Acute	Aquatic Plants (vascular)	duckweed	EC_{50} =41 ppb; NOAEC = <8 ppb
	(Nonvascular)	marine diatom	EC_{50} = 5.2 ppb

[1] No effects on any reproductive parameter or viability of of F_1 offspring at the highest dose tested, 1000 ppm; however due to excessive mortality (33%) of adult female birds in that dose level, a NOAEC for chronic effects was set at 500 ppm.

[2] LOAEL of $\geq$38 mg/kg/ day (400 ppm) for inactive mammary tissue and fetal/pup death observed in the one year range-finding test of a rat reproduction study. NOAEC = 200 ppm.

[3] Rainbow trout was more sensitive than the fathead minnow (fathead minnow NOAEC= 33 ppb).

[4] Extrapolation from acute/chronic ratio.

CHAPTER 3: INTEGRATED ENVIRONMENTAL RISK CHARACTERIZATION

Oxadiazon is a persistent, lipophilic compound that has low mobility in most soils (not expected to move to ground water), and may be susceptible to aqueous photolysis. Oxadiazon is also a light-dependent peroxidizing herbicide (LDPH) that has the potential for the induction of phototoxicity (exposure to light results in the development of free radicals that can destroy cell membranes). Our risk assessment shows that chronic exposure of this compound to aquatic organisms (estuarine/marine fish and aquatic invertebrates) can result in significant reproductive effects (EFED's runoff and drift exposure scenarios). Aquatic risk is further compounded by oxadiazon's ability to sorb and accumulate in the sediment. As a contrast, terrestrial concerns for this compound are mixed. The potential for chronic risk to mammals appears very high and could result in significant reproductive effects. However, chronic risk to birds appeared to be a relatively lower concern although values still exceed EFED's level of concern (LOC). Our analysis also noted that acute exposure of oxadiazon (emulsifiable concentrate and granular) to birds and mammals should not present significant short term toxic risk. EFED also has a concern that exposure of oxadiazon to aquatic and terrestrial systems may result in a potential risk to endangered species that can include mammals, birds, fish and aquatic invertebrates. Since this compound is a herbicide, there is the potential for impact to nontarget plants (terrestrial, semi-aquatic and aquatic). However, this possible risk to nontarget plants cannot be fully assessed at this time due to the lack of acceptable data.

The focus of this risk assessment is based on toxicity and exposure values (risk quotients or RQs as the ratio of exposure/toxicity), the disposition (fate) of oxadiazon in the environment, and its mode of action as a phototoxic compound. In order to evaluate the potential for risk to non target organisms, our assessment is divided into aquatic and terrestrial exposure scenarios. The aquatic component was evaluated through GENEEC2 pond scenario while terrestrial impact was assessed through the ELL-FATE model. Since oxadiazon is primarly used as a herbicide on turf, especially golf courses, EFED has evaluated the proximity of these areas to estuarine/marine environments, and the ecological significance of application timing.

Oxadiazon is a stable and persistent compound. However, direct aqueous photolysis half-life of about 3 days suggests that in clear and shallow surface water bodies where sunlight penetration can be significant, photolytic degradation of oxadiazon is possible. However, this photolytic effect may also substantially diminish in turbid and deeper water bodies. Soil photolysis and hydrolysis under acidic and basic conditions do not appear to be an important dissipation mechanism. Microbial metabolism in soil and aquatic environments under either aerobic and anaerobic condition is not expected to cause any significant transformation of oxadiazon. Studies on equilibrium sorption and aged/unaged oxadiazon indicate that the pesticide has low environmental mobility (K_d's ranged from 8.17 to 22.83; K_{oc}'s ranged from 1409 to 3268). Thus, oxadiazon can be transported on erodible soil particles via runoff events to nearby surface water bodies. Leaching from surficial soils to groundwater is expected to be low or negligible, unless the soil is very porous or has some cracks that favor preferential flow. Oxadiazon exhibited slow dissipation in two field terrestrial studies conducted in California and North Carolina.

Our review has found that golf courses can represent about 2,300,000 acres in the USA. About half of this acreage is located in counties that are considered coastal and close to estuarine/marine environments

and tributaries. Because of the proximity to these aquatic habitats to golf courses, EFED has a concern for any persistent compound that has the potential for runoff and toxicity to aquatic systems that include estuaries. Many of these aquatic areas have significant fisheries that can account for over 65% of the commercial catches for the USA. (e.g., Chesapeake Bay, Long Island Sound, The Gulf of Mexico, San Diego Bay, San Francisco Bay, Puget Sound, etc.). Impact to this resource could effect not only the ecological value but the livelihood of fishing communities and markets at a local and national level.

Since oxadiazon is stable to hydrolysis and persistent in the environment, the results from our Tier I (GENEEC2) pond scenario model suggest that chronic exposure of oxadiazon can result in significant long term risk to freshwater and estuarine/marine fish and aquatic invertebrates. Our screening level assessment shows that the RQ values that were generated exceeded the LOC by significant amounts of 4 - 132 fold (application rates of 2.0 - 4.0 lbs ai/A EC and granular formulation). The issue of chronic toxicity is compounded by the lipophilic nature of oxadiazon. Since this stable compound can be absorbed to particulate and organic carbon, oxadiazon residues can accumulate in sediments and increase the potential for chronic risk to benthic and epibenthic organisms (aquatic organisms that live in or on the sediment). Acting as a repository for lipophilic compounds, sediments can impact aquatic organisms through respiration, ingestion, dermal contact, and/or indirect impact through alterations of the food chain. This can present a significant risk to aquatic organisms because about 80% of all aquatic life in estuaries is in contact with the benthos. Therefore, in order to better understand this potential risk, EFED is requiring appropriate sediment toxicity testing (acute and chronic) on this compound. Another issue of concern is the uncertainty regarding the degree of phototoxicity of this compound to aquatic organisms. Since oxadiazon is a light-dependent peroxidizing herbicide (LDPH), enhanced toxicity through exposure to high levels of solar radiation may increase toxic risk to aquatic organisms that inhabit small, shallow water bodies (toxicity is increased through the production of free radicals which actively destroy cell membranes). This can be very critical to several species of aquatic organisms (fish, crabs, etc) whose early life stages are dependent upon these relatively shallow areas for their development. The herbicidal properties of oxadiazon also suggest the potential for acute toxicity to aquatic plants and the possibility of aquatic habitats alterations. This can potentiate an indirect effect to aquatic populations through a decrease in plant cover. In addition to toxic risk to non target aquatic organisms, oxadiazon may also impact endangered species (fish and invertebrates).

The potential for birds and mammals to be exposed to pesticides through a turf use has been documented (e.g., chlorpyrifos, lindane). The application of oxadiazon in the spring as noted from the label, can coincide with several avian and mammalian reproductive cycles, as well as spring migrations (avian). In order to evaluate the potential for risk to terrestrial organisms, EFED has conducted a Tier I assessment by using the ELL-FATE model. In order to evaluate possible toxic risk to terrestrial organisms, three application rates (4.0, 3.0, and 2.0 lbs ai/A, at 2 applications/6 months) and two split applications (1.0 lbs ai/A applied 4 times/6 month and 1.3 lbs ai/A applied 3 times/6 month) were run. Our objective was to find not only the highest rate that may cause toxic risk, but the rate that might result in lower risk. Our assessment noted that acute risk to birds and mammals was minimal and should not present any short term toxic concern to these organisms. However, all application scenarios showed that chronic exposure could result in significant risk to mammalian herbivores and insectivores (15g, 35g, and 1000g) with RQ exceedences of 1.5 - 9.9 fold. In contrast to mammalian chronic risk, our assessment also noted that

chronic exposure to birds could result in relatively lower RQ values that showed exceedence of about 1 to 2 fold the LOC. This could be interpreted as potentially low toxic risk (chronic) to birds that feed on plants and grass (e.g., ducks, geese). A reduction in chronic risk to birds was noted with the split application scenarios (RQ $\leq$ 1), but chronic risk to mammals was still very high even with this scenario. Exposure from the granular formulation was evaluated because birds may be exposed to granular pesticides through ingestion when foraging for food or grit. RQ values were calculated for three weight classes of birds (1000g waterfowl, 180g upland game bird, and 20g songbird). All scenarios for the granular resulted in no acute risk to birds (EFED does not conduct a chronic assessment from granular exposure).

The potential for chronic risk (high for mammals but relatively low for birds) that has been noted for terrestrial organisms suggests that oxadiazon may present a risk to both avian and mammalian endangered species (RQ $\geq$ 0.1), even though the acute LOC values were not exceeded. Although, risk to terrestrial plants could not be conducted at this time (lack of data), oxadiaxon's herbicidal mode of action suggests that there is a potential for risk to nontarget terrestrial plants, as well as endangered plants. Since oxadiazon is practically non-toxic to the honey bee, minimal risk to these organisms is anticipated.

The Agency is currently engaged in a Proactive Conservation Review with FWS and the National Marine Fisheries Service under section 7(a)(1) of the Endangered Species Act. The objective of this review is to clarify and develop consistent processes for endangered species risk assessments and consultations. Subsequent to the completion of this process, the Agency will reassess the potential effects of oxadiazon use to federally listed threatened and endangered species. At that time the Agency will also consider any regulatory changes recommended in the RED that are being implemented. Until such time as this analysis is completed, the overall environmental effects mitigation strategy articulated in this document and any County Specific Pamphlets which address oxadiazon, will serve as interim protection measures to reduce the likelihood that endangered and threatened species may be exposed to oxadiazon at levels of concern. The endangered species LOCs for liquid and granular formulations of oxadiazon are exceeded for chronic risks to birds and mammals and acute/chronic risk to freshwater and estuarine fish and invertebrates and aquatic vascular plants. Although the terrestrial plant data are outstanding, it is assumed that endangered terrestrial plants are at risk since oxadiazon is an herbicide. Although the endangered species LOC for estuarine invertebrates has been exceeded, there are no listed species in this group.

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen- and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, oxadiazon, may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption. Issues that have raised this concern include fish reproduction effects (larval and embryo survival, egg hatchability) and invertebrate reproduction effects (reduced neonate production).

CHAPTER 4: ENVIRONMENTAL FATE AND TRANSPORT ASSESSMENT

Basic Physicochemical Parameters

The important properties of oxadiazon are summarized below. Oxadiazon is a high-molecular-weight compound with fairly low solubility in water and high solubility in organic solvents. It has a low vapor pressure and Henry's Law Constant (<< 1 x 10^{-3} atm-m^{-3}/mol) suggesting that volatilization from soil and surface water environments is not important. Its high Kow value tends to indicate that bioconcentration in aquatic organisms such as fish is possible. Nevertheless, the high bioconcentration factors observed in studies using bluegill sunfish can be offset by fast depuration rate.

Molecular formula:	$C_{15}H_{18}Cl_2N_2O_3$.
Molecular weight:	345.2.
Physical state:	Colorless crystals.
Vapor pressure (20°C):	1.00x10^{-6} mm Hg
Henry's Constant:	4.51x10^{-7} Atm•m^3/mol
Solubility (20°C):	1 ppm water (25°C)
	600 g/L acetone, acetophenone, anisole
	1 kg/L benzene, chloroform, toluene
	100 g/L ethanol, methanol
K_{ow}:	63,100
$\log_{10} K_{ow}$:	4.8

Fate and Transport Processes - Summary

Based on fate studies reviewed, oxadiazon would be stable and persistent under typical natural environment. However, direct aqueous photolysis half-life of about 3 days (summer sunlight conditions in Florida) suggests that in clear and shallow surface water bodies where sunlight penetration can be significant, photolytic degradation of oxadiazon is possible. The photolytic effect though may substantially diminish in turbid and deeper water bodies. Soil photolysis and hydrolysis under acidic and basic conditions do not appear to be an important dissipation mechanism. Microbial metabolism in soil and aquatic environments under either aerobic and anaerobic condition is not expected to cause any significant transformation of oxadiazon. A number of degradates have been reported from the different chemical and biological fate studies. The nomenclature of these degradates are summarized in Appendix 3 (move nomenclauture on page to 20 to this Appendix 3).

Studies on equilibrium sorption and aged/unaged oxadiazon indicate that the pesticide has low environmental mobility (K_d's ranged from 8.17 to 22.83; K_{oc}'s ranged from 1409 to 3268). Thus, oxadiazon can be transported as sorbed species to erodible soil particles via surface runoff to nearby surface water bodies. Leaching from surficial soils to groundwater is expected to be low or negligible, unless the soil is very porous or has some cracks that favor preferential flow. Oxadiazon exhibited slow dissipation in two field terrestrial studies conducted in California and North Carolina. Details of all the fate and transport studies are discussed in Appendix B.

CHAPTER 5: DRINKING WATER ASSESSMENT

a. Estimated Environmental Concentrations and Drinking Water Concentration Estimates

TierI screening models, FIRST and SCIGROW, were used to determine estimated environmental concentrations (EECs) of oxadiazon in surface water and groundwater associated with the ground spray application of 4.0 lbs a.i./A (applied two times a year) in turf. FIRST estimates surface water concentrations resulting from runoff of applied pesticides from a treated area to an adjacent index water reservoir in which the percent or fraction of cropped area (0.87) is taken into account. SCIGROW predicts groundwater concentrations after leaching of pesticides from the surficial soils and/or subsurface horizons to the aquifer. The screening concentrations derived from the two models are used in the evaluation of human exposure to contaminated drinking water. Details about the two models, including the input parameters and computer output printouts for turf scenario, are presented in Appendix E (Drinking Water Memo).

Surface Water

The results of FIRST modeling for the acute and chronic surface water EECs are summarized in the table below. The acute (246 ppb) and chronic (100 ppb) values represent the peak and annual average concentrations predicted by the model. These values generally represent upper bound estimates. The values are relatively higher than the two similar oxadiazon detections (0.05 ug/L) in Larue, KY reported in the 1997 surface water monitoring data of the STORET system. Therefore, based on the data available, EFED conservatively recommends to use the model-predicted values for surface derived drinking water concentrations.

Table 3. Estimated Tier I concentrations of oxadiazon in drinking water

Chemical	Surface Water (ug/L)		Groundwater (ug/L)
	Acute	Chronic	Acute and Chronic
Oxadiazon	246	100	0.6

Groundwater

As shown in Table 3, the groundwater concentration estimated from SCIGROW is 0.6 ppb which is about two orders of magnitude lower than those of surface water. This concentration may be used for both acute and chronic values. The low concentration is consistent with both laboratory and field studies that indicate the low mobility of oxadiazon, and subsequently, its reduced potential to reach groundwater.

CHAPTER 6: AQUATIC EXPOSURE AND RISK ASSESSMENT

a. Aquatic (Acute/Chronic Hazard Summary)

Oxadiazon is considered to be moderately toxic on an acute basis to freshwater fish (LC_{50} = 0.88-1.2 ppm) and estuarine/marine fish (LC_{50} = 1.5 ppm). However, chronic NOAEC/LOAEC were determined for freshwater fish at 0.88/1.7 ppb with egg hatchability as the endpoint effected. Oxadiazon has the potential for high acute toxicity to estuarine/marine invertebrates (EC_{50} = 0.27 - 0.7 ppb) but appears to be moderately toxic to freshwater invertebrates (LC_{50} = 2.18 - 2.4 ppm). Chronic toxicity to freshwater invertebrates shows reproductive effects (mean time to first brood, # young/adult/reproductive day, survival, growth) with a NOAEC/LOAEC = 30.0/35.0 ppb. The limited data on plant toxicity shows that oxadiazon is toxic to non-vascular aquatic plants (marine diatom EC_{50} = 5.2 ppb) and vascular aquatic plants (duckweed EC_{50} = 41 ppb).

b. Risk to Aquatic Organisms (Acute/Chronic)

Tables 4 and 5 provide acute and chronic RQ values for oxadiazon exposure to freshwater and estuarine/marine species relative to turf use patterns (application rates for EC at 2.0 - 4.0 lbs ai/A and 4.0 lbs ai/A for granular). **Our Tier I (GENEEC) risk assessment suggests that chronic exposure of this compound can result in significant chronic risk to freshwater and estuarine/marine fish (RQ = 39.3 - 131.8) and aquatic invertebrates (RQ = 3.9 - 36.7). Although our assessment further suggests that oxadiazon acute exposure may result in low acute risk to fish (RQ = 0.1 - 0.2) and invertebrates (RQ = 0.3 - 0.5), there is uncertainty regarding the potential for enhanced risk that may occur through phototoxicity.** Since oxadiazon is a light-dependent peroxidizing herbicide (LDPH), enhanced toxicity through exposure to high levels of solar radiation is a possible concern regarding aquatic organisms that inhabit small, shallow water bodies. Endangered species concerns are also suggested with RQ = 0.1.

Aquatic plant acute high risk levels of concern are exceeded (Table 6 and 7) for both vascular and nonvascular plants. The exceedences range 1 - 4 fold for vascular plants and 8.5 - 33 fold for non-vascular plants. The acute plant high risk level of concern is exceeded for vascular plants with an exceedence range of 5.5 -22 fold. Currently, EFED does not perform assessments for chronic risk to aquatic plants.

Table 4. Acute and chronic RQ's for evaluating toxic risk of oxadiazon exposure to fish (freshwater and estuarine/marine). RQ's are based on the bluegill (*Lepomis macrochirus*) LC_{50} = 0.88 ppm, rainbow trout (*Oncorhynchus mykiss*) NOAEC = 0.00088 ppm and sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 1.5 ppm., NOAEC = 0.0015 ppm[1]. EEC values are generated from GENEEC and reflect three of the highest proposed EC application rates, and the maximum granular use rate (4.0, 3.0, and 2.0 lbs ai/A, 2 applications each; 4.0 lbs ai/A, 2 applications, respectively) for turf use.

Crop App. Rate (lbs ai/A; # App.)	Organism	LC_{50} (ppm)	NOAEC (ppm)	EEC Peak (ppm)	EEC 60-Day Ave. (ppm)	Acute RQ (EEC/LC_{50})	Chronic RQ (EEC/NOAEC)
Turf (EC) 4.0 (2)	Freshwater	0.88	0.00088	0.143	0.116	**0.2**[2]	**131.8**[3]
	Estuarine/ Marine	1.5	0.0015[1]	0.143	0.116	**0.1**[2]	**77.3**[3]
Turf (EC) 3 (2)	Freshwater	0.88	0.00088	0.130	0.122	**0.1**[2]	**139.0**[3]
	Estuarine/ Marine	1.5	0.0015[1]	0.130	0.122	**0.1**[2]	**81.3**[3]
Turf (EC) 2 (2)	Freshwater	0.88	0.00088	0.088	0.083	**0.1**[2]	**94.3**[3]
	Estuarine/ Marine	1.5	0.0015[1]	0.088	0.083	**0.0**	**55.3**[3]
Turf (Granular) 4.0 (2)	Freshwater	0.88	0.00088	0.122	0.099	**0.1**[2]	**112.5**[3]
	Estuarine/ Marine	1.5	0.0015[1]	0.122	0.099	**0.1**[2]	**66.0**[3]

[1] Extrapolated chronic value using acute/chronic freshwater toxicity ratio
[2] Acute restrictive use ($\geq$ 0.1), acute species
[3] Chronic concern ($\geq$ 1.0)

Table 5. Acute and chronic risk RQ's for evaluating toxic risk of oxadiazon exposure to aquatic invertebrates (freshwater and estuarine / marine). RQ's are based on Daphnia *(Daphnia magna)* EC_{50} = 2.18 ppm, NOAEC = 0.03 ppm and the Mysid shrimp (*Americamysis bahia*) EC_{50} = 0.27 ppm, NOAEC = 0.0037 ppm[1]. EEC values are generated from GENEEC and reflect three of the highest proposed EC application rates, and the maximum granular use rate (4.0, 3.0, and 2.0 lbs ai/A, 2 applications each; 4.0 lbs ai/A, 2 applications, respectively) for turf use.

Crop App. Rate (lbs ai/A) # App. (days)	Organism	EC_{50} (ppm)	NOAEC (ppm)	EEC Peak (ppm)	EEC 21-Day Ave. (ppm)	Acute RQ (EEC/ LC_{50})	Chronic RQ (EEC/NOAEC)
Turf (EC) 4.0 (2)	Freshwater	2.18	0.03	0.143	0.136	**0.1**[2]	**4.5**[1]
	Estuarine/ Marine	0.27	0.0037	0.143	0.136	**0.5**[2]	**36.7**[1]
Turf (EC) 3.0 (2)	Freshwater	2.18	0.03	0.130	0.127	**0.5**[2]	**4.2**[1]
	Estuarine/ Marine	0.27	0.0037	0.130	0.127	**0.5**[2]	**34.3**[3]
Turf (EC) 2.0 (2)	Freshwater	2.18	0.03	0.088	0.086	**0.0**	**2.9**[3]
	Estuarine/ Marine	0.27	0.0037	0.088	0.086	**0.3**[2]	**23.2**[3]
Turf (Granular) 4.0 (2)	Freshwater	2.18	0.03	0.122	0.116	**0.0**	**3.9**[1]
	Estuarine/ Marine	0.27	0.0037	0.122	0.116	**0.4**[2]	**31.3**[1]

[1] Extrapolated chronic value using acute/chronic freshwater toxicity ratio
[2] Acute restrictive use ($\geq$ 0.1)
[3] Chronic concern ($\geq$ 1.0)

Exposure and Risk to Aquatic Plants

Exposure to nontarget aquatic plants may occur through runoff or spray drift from adjacent treated sites. An aquatic plant risk assessment for acute high risk is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Non-vascular acute high aquatic plant risk assessments are performed using either algae or a diatom, whichever is the most sensitive species. Runoff and drift exposure are computed from GENEEC2 and the risk quotient is determined by dividing the pesticide's initial or peak concentration in water by the plant EC_{50} value. Acute risk quotients for vascular and non-vascular plants are tabulated in Table 6.

Table 6. Acute Risk Quotients for Aquatic Plants based upon a duckweed (*Lemna gibba*) EC_{50} of 41 ppb and a nonvascular plant (marine diatom) EC_{50} of 5.2 ppb.

Turf/ Rate of Application in lbs ai/A (Number of Applications).	Species	EC_{50} (ppm)	EEC (ppm)	Non-target plant RQ (EEC/EC_{50})
4 (1)	duckweed	0.041	0.173	**4.2**
4 (1)	"	0.041	0.089	**2.2**
3 (1)	"	0.041	0.067	**1.6**
2 (1)	"	0.041	0.044	**1.1**
4 (2)	diatom	0.0052	0.173	**33.3**
4 (1)	"	0.0052	0.089	**17.1**
3 (1)	"	0.0052	0.067	**12.9**
2 (1)	"	0.0052	0.044	**8.5**

The acute high risk levels of concern for aquatic plants are exceeded for both vascular and nonvascular plants. The exceedences range 1 - 4 fold for vascular plants and 8.5 - 33 fold for non-vascular plants. Currently, EFED does not perform assessments for chronic risk to aquatic plants.

Table 7. Species Risk Quotients on turf for aquatic plants based upon a duckweed (*Lemna gibba*) NOAEC of <8 ppb.

Rate of Application in lbs ai/A (Number of Applications).	Species	EC_{50} (ppm)	EEC (ppm)	Non-target plant RQ (EEC/EC_{50})
4 (2)	duckweed	0.008	0.173	**21.6**
4 (1)		0.008	0.089	**11.1**
3 (1)		0.008	0.067	**8.4**
2 (1)		0.008	0.044	**5.5**

An analysis of the results indicate that the plant acute high risk level of concern is exceeded for vascular plants with exceedences ranging 5.5 -22 fold.

CHAPTER 7: TERRESTRIAL EXPOSURE AND RISK

a. Terrestrial Hazard Summary

The available toxicity data are listed in Appendix D. Oxadiazon appears to be practically non-toxic to avian species on an subacute basis (Northern bobwhite quail and mallard duck LC_{50} > 5,000 ppm) and slightly to practically non-toxic to birds on an acute basis (bobwhite quail LD_{50} >2,150 mg/kg; mallard LD_{50} = 1,040 mg/kg). Chronic testing showed no reproductive effects at 500 ppm.. At greater than 1,000 ppm mortality was noted for adult females (bobwhite quail).

Mammalian toxicity data suggest that this compound is practically non-toxic to small mammals on an acute basis (rat LD_{50} > 5,000 mg/kg). Reproductive effects were noted at > 200 ppm that resulted in inactive mammary tissue and fetal/neonatal death. Acute toxicity studies to honey bees show that oxadiazon was practically non-toxic (LD_{50} > 25 ug/bee).

b. Risk to Avian Species (Acute/Chronic)

Table 8 provides avian acute and chronic RQs from exposure to multiple applications of oxadiazon EC to turf for the maximum three application rates (4.0, 3.0 and 2.0 lbs ai/A) and two split applications (1.0 lb ai/A, 4 times/6 months; 1.3 lbs ai/A, 3 times/6 months). The maximum three applications have the potential for chronic exposure to birds that feed on plants and grass (e.g., ducks, geese) and may result in toxic risk to these birds (RQ = 1.0 - 2.0). The split application appears to lower this chronic exposure and risk (RQ $\leq$ 1). Exposure from the granular formulation was evaluated (Appendix F) because birds may be exposed to granular pesticides through ingestion when foraging for food or grit. RQ values were calculated for three weight classes of birds (1000g waterfowl, 180g upland game bird, and 20g songbird). All scenarios for the granular resulted in no acute risk to birds (RQ < 1.5 - 2.0). However, the potential chronic concern noted for non endangered birds suggest that oxadiazon may present a risk to endangered species (RQ > 0.1)

The estimated environmental concentration (EEC) values used for foliar terrestrial exposure are derived from the Kenega nomograph, as modified by Fletcher *et al.* (1994), based on a large set of actual field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenega, 1972). The Fletcher *et al.*, (1994) modifications to the Kenega nomograph are based on measured field residues from 249 publications, including information on 118 species of plants, 121 pesticides, and 17 chemical classes. These modifications represent the 95th percentile of the expanded data set. Risk quotients are based on the most sensitive LC_{50} and NOAEC for birds. EFED also used the ELL- FATE model for multiple applications, incorporating the appropriate dissipation half-life to generate EECs. Single application EECs reflect day zero maximum Fletcher residue values (lbs ai/A x 240; 110; 135; 15 ppm).

Current EFED policy assumes that pesticide dissipation from foliar surfaces is primarily due to degradation or dissipation by one or more processes including, photolysis, hydrolysis, microbial

degradation and volatilization. If adequate foliar dissipation data are not available then a half-life not to exceed 35 days will be used in the EEC calculations.

Table 8. Avian acute and chronic risk quotients (RQ's) as generated through ELL-FATE for broadcast ground spray applications for oxadiazon. RQ's are based on mallard duck LC_{50} > 5,000 ppm and NOAEC = 500 ppm. The EEC reflects the turf use with the three highest use rate (4.0, 3.0 and 2.0 lbs ai/A, 2 applications) and two split applications (1.0 lb ai/A, 4 times/6 months; 1.3 lbs ai/A, 3 times/6 months).

Site Application Rate lbs ai/A (# appl)	Food Item	Maximum EECs (ppm)	Acute RQ (EEC/LC_{50})	Chronic RQ (Max. EEC/NOAEC)
Turf (EC) 4.0 (2)	Short grass Tall grass Broadleaf plants/insects Seeds	984.1 451.1 553.6 61.5	< 0.2 < 0.1 < 0.1 < 0.0	**2.0** **1.0** 0.1 0.1
Turf (EC) 3.0 (2)	Short grass Tall grass Broadleaf plants/insects Seeds	739.6 339.0 416.0 46.2	<0.1 0.0 <0.1 0.0	**1.5** **1.0** **1.0** 0.1
Turf (EC) 2.0 (2)	Short grass Tall grass Broadleaf plants/insects Seeds	493.1 226.0 277.3 30.8	<0.1 0.0 0.0 0.0	**1.0** 0.4 0.5 0.1
Turf (EC) 1.0 (split 4 applications/ 6 months)	Short grass Tall grass Broadleaf plants/insects Seeds	424.4 194.5 238.7 26.5	<0.1 0.0 0.0 0.0	**1.0** 0.4 0.5 0.1
Turf (EC) 1.3 (split 3 applications/ 6 months)	Short grass Tall grass Broadleaf plants/insects Seeds	257.0 117.8 144.6 16.1	<0.1 0.0 0.0 0.0	**1.0** 0.4 0.5 0.1

c. Risk to Mammalians (Acute, Chronic)

Our assessment (Table 9 and 10) suggests that the proposed use rates (4.0, 3.0 and 2.0 lbs ai/A), as well as the split use rates (1.0 and 1.3 lbs ai/A) should not result in acute risk to mammals (RQ $\leq$ 0.2). However, these application scenarios can result in significant chronic exposure and risk to mammalian herbivores and insectivores (15g, 35g, and 1000g) with RQ values ranging from 1.0 - 4.9. This chronic risk to non endangered mammalian species also suggests the potential for impact to endangered species.

Estimating the potential for adverse effects to wild mammals is based upon EFED's draft 1995 SOP of mammalian risk assessments and methods used by Hoerger and Kenaga (1972) as modified by Fletcher et al., (1994). The concentration of oxadiazon in the diet is expected to be acutely toxic to 50% of the test organisms is determined by dividing the LD_{50} value (usually the rat LD_{50}) by the per cent body weight consumed. A risk quotient is then determined by dividing the EEC by the acute toxicity value.

$$RQ = \frac{\text{EEC (ppm)}}{LD_{50}\text{ (mg/kg)/ \% Body weight consumed}}$$

RQ values are calculated for four different kinds of food (short grass, tall grass, forage/insects, and seeds) that are expected to be consumed by mammalian herbivores, insectivores, and granivores. The per cent body weight consumed for herbivores and insectivores corresponding to the three weight categories (15, 35, and 1000 g) is assumed to be 95%, 66%, and 15%, respectively. Granivores are expected to have a different per cent body weight consumption for the same weight categories (21%, 15%, and 3%, respectively). Chronic toxicity values were based on the NOAEC from a rat reproductive study. In order to evaluate chronic concerns, a maximum EEC was generated through the ELL-FATE model that takes into consideration pesticide half-life, application rate, number of applications, and intervals between applications (first order kinetics model). In order to evaluate possible toxic risk to terrestrial organisms, three application rates (4.0, 3.0, and 2.0 lbs ai/A, at 2 applications/6 months) and two split applications (1.0 lbs ai/A applied 4 times/6 month and 1.3 lbs ai/A applied 3 times/6 month) were run. Our objective was to find not only the highest rate that may cause toxic risk, but the lowest rate that might result in lower risk.

Table 9. Mammalian acute risk quotients as generated through ELL-FATE for ground application of oxadiazon (EC). RQ's are based on rat (*Rattus norvegicus*) LD_{50} > 5,000 mg/kg,. The EEC reflects the three highest use rate (4.0, 3.0 and 2.0 lbs ai/A, 2 applications) and two split applications (1.0 lb ai/A, 4 times/6 months; 1.3 lbs ai/A, 3 times/6 months).

Crop Application Rate lbs ai/A (# of applications)	Body Wt. (g)	% Body Wt. Consumed	Acute RQ Short Grass	Acute RQ Forage and Small Insects	Acute RQ Large Insects	Acute RQ Seeds
Turf (EC) 4.0 (2)	15	95/21	<0.2	<0.1	<0.1	0.0
	35	66/15	<0.1	<0.1	<0.1	0.0
	1000	15/3	0.0	0.0	0.0	0.0
Turf (EC) 3.0 (2)	15	95/21	<0.1	0.0	0.0	0.0
	35	66/15	<0.1	0.0	0.0	0.0
	1000	15/3	0.0	0.0	0.0	0.0
Turf (EC) 2.0 (2)	15	95/21	<0.1	0.0	0.0	0.0
	35	66/15	<0.1	0.0	0.0	0.0
	1000	15/3	0.0	0.0	0.0	0.0
Turf (EC) 1.0 (split 4 applications/ 6 months)	15	95/21	<0.1	0.0	0.0	0.0
	35	66/15	<0.1	0.0	0.0	0.0
	1000	15/3	0.0	0.0	0.0	0.0
Turf (EC) 1.3 (split 3 applications/ 6 months)	15	95/21	<0.1	0.0	0.0	0.0
	35	66/15	<0.1	0.0	0.0	0.0
	1000	15/3	0.0	0.0	0.0	0.0

[1] Acute species concerns (≥ 0.1)
[2] Acute restricted use (≥ 0.2)

Table 10. Mammalian chronic risk quotients as generated through ELL-FATE for ground application of oxadiazon are based on rat (*Rattus norvegicus*) NOAEC = 200 ppm. The EEC reflects the three highest use rate (4.0, 3.0 and 2.0 lbs ai/A, 2 applications) and two split applications (1.0 lb ai/A, 4 times/6 months; 1.3 lbs ai/A, 3 times/6 months).

Crop Application Rate lbs ai/A (# of applications)	Food Items	Max. EEC (ppm)	Chronic RQ (Max. EEC/NOAEC)
Turf (EC) 4.0 (2)	Short Grass	986.1	**4.9**[1]
	Tall Grass	452.0	**2.3**[1]
	Broadleaf plant/ Insects	554.7	**2.8**[1]
	Seeds	61.6	0.3
Turf (EC) 3.0 (2)	Short Grass	739.6	**3.7**[1]
	Tall Grass	339.0	**1.7**[1]
	Broadleaf plant/ Insects	416.0	**2.1**[1]
	Seeds	46.2	0.2
Turf (EC) 2.0 (2)	Short Grass	493.1	**2.4**[1]
	Tall Grass	226.0	**1.1**[1]
	Broadleaf plant/ Insects	227.3	**1.4**[1]
	Seeds	30.8	0.1
Turf (EC) 1.0 (split 4 applications/ 6 months)	Short Grass	424.4	**2.4**[1]
	Tall Grass	194.5	**1.1**[1]
	Broadleaf plant/ Insects	238.7	**1.3**[1]
	Seeds	26.5	0.1
Turf (EC) 1.3 (split 3 applications/ 6 months)	Short Grass	257.0	**1.6**[1]
	Tall Grass	117.8	**1.0**[1]
	Broadleaf plant/ Insects	144.6	**1.0**[1]
	Seeds	16.1	0.1

[1] Chronic risk (LOC $\geq$ 1)

d. Risk to Non-target Insects

EFED does not do risk assessments on insects. However, it appears that oxadiazon exposure to honeybees should present low risk.

e. Risk to Terrestrial Plants

The risk assessment of oxadiazon to terrestrial plants and aquatic plants (vascular and nonvascular) cannot be completed because of an inadequate data base. It should be noted that the assessment for nonvascular plants provided here is incomplete in that the assessment is based on a supplemental study and additional nonvascular plant species testing is being recommended.

f. Endocrine Disruption

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally-occurring estrogen, or other such endocrine effects as the Administrator may designate." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen- and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and or testing protocols being considered under the Agency's Endocrine Disruptor Screening Program have been developed, oxadiazon, may be subjected to additional screening and or testing to better characterize effects related to endocrine disruption. Issues that have raised this concern include the findings from fish reproduction effects (larval and embryo survival, egg hatchability) and invertebrate reproduction effects (reduced neonate production) also suggest endocrine disruption.

Conclusions

The Tier I GENEEC calculated RQ values for the use of oxadiazon on turf suggests that chronic exposure of this compound has the potential for toxic risk to freshwater and estuarine/marine fish (RQ = 39.3 - 131.8) and aquatic invertebrates (RQ = 3.9 - 36.7). The chronic Level of Concern (LOC) was exceeded by up to 132-fold for fish and 37-fold for aquatic invertebrates. Although our initial risk assessment suggests that acute exposure of oxadiazon to aquatic systems should result in relatively lower short term risk to non endangered fish and aquatic invertebrates (RQ = 0.1 - 0.5) there is uncertainty regarding possible risk enhancement through phototoxicity. Since oxadiazon is a light-dependent peroxidizing herbicide (LDPH), enhanced toxicity through exposure to high levels of solar radiation is a possible concern regarding aquatic organisms that inhabit small, shallow water bodies. Oxadiazon is also a lipophilic, persistent compound that can be absorbed to particulate and sediment. This combination of chemical/physical attributes and the relatively high toxicity profile to fish and invertebrates suggest concern for accumulation in the sediments. Since sediments can act as a repository for lipophilic compounds, there can be direct impact to aquatic organisms through respiration, ingestion, dermal contact, and/or indirect impact through alterations of the food chain. The herbicidal properties of this compound also suggest toxicity to aquatic plants and the resulting alteration of habitats.

Our terrestrial risk assessment for the oxadiazon EC use on turf was conducted by using the ELL-FATE model. An evaluation of EECs generated for each of the three application rates (4.0, 3.0, and 2.0 lbs ai/A) and split applications (1.0 and 1.3 lbs ai/A) showed that oxadiazon chronic exposure to mammals (RQ = 1.0 - 4.9) has the potential for toxic risk. Chronic risk to mammalians can be 5 fold greater than the LOC with the potential to impact herbivores, granivores and insectivores. Relative to mammalian effects, chronic risk to avian species (RQ = 1.0 - 2.0) appears lower but still exceeds EFEDs LOC (RQ =1). This exposure may result in impact to herbivorous birds which feed on grass, broadleaf plants, etc. Although acute exposure of this compound should not present a toxic risk to non endangered avian or mammalian species (RQ < 0.1), the potential for chronic risk suggests a possible endangered avian species concern. Exposure from the granular formulation was evaluated (Appendix F) because birds may be exposed to granular pesticides through ingestion when foraging for food or grit. RQ values were calculated for three weight classes of birds (1000g waterfowl, 180g upland game bird, and 20g songbird). The maximum use rate scenarios for the granular resulted in acute risk to small songbirds (RQ = 1.5 - 2.0).

Since oxadiazon is practically non-toxic to the honey bee, minimal risk to these organisms is anticipated. However, since oxadiazon is a herbicide, risk to non-nontarget aquatic and terrestrial plants can be anticipated. RQ's generated for Tier I testing of aquatic plants (vascular RQ = 1.1 - 4.2 and nonvascular RQ = 8.5 - 33.3) show the potential for toxic risk to aquatic plants. Although there does not appear to be an acute risk to endangered birds and mammals there may be chronic concerns as reflected in the two-fold LOC exceedences for non endangered terrestrial animals. Therefore, our assessment suggests that endangered terrestrial species (birds, mammals, and terrestrial plants) may be at risk.

Aquatic studies that showed fish reproduction effects (larval and embryo survival, egg hatchability) and invertebrate reproduction effects (reduced neonate production) suggest that oxadiazon may be subject to additional screening or testing to better characterize effects related to possible endocrine disruption.

APPENDIX A: REFERENCES CITED

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APPENDIX B: FATE SUMMARIES

161-1 Hydrolysis (MRID# 41863603; Core)

[^{14}C]-Oxadiazon (phenyl ring-labeled), at 0.48 mg/L, was stable in pH 4, 5, and 7 sterile aqueous buffered solutions incubated in the dark at 25°C for 31 days.

At pH 9, oxadiazon was hydrolyzed with a calculated half-life of 38 days. Oxadiazon averaged 93.64% of the applied at 5 days, and 49.98% at 31 days. The main degradate found was

- 1-trimethyl acetyl-2-(2,4-dichloro-5-isopropoxyphenyl) hydrazine (RP26123), which increased to 45% of the applied at 31 days.

All other metabolites were present at <10% of the applied.

161-2 Photodegradation in Water (MRID# 41897201; Core)

[^{14}C]oxadiazon (phenyl ring-labeled), at 0.5 mg/L, photodegraded with a half-life of 21.2 hours (or the equivalent of 2.75 days of summer sunlight in Florida) in pH 5 buffered solutions that were continuously irradiated with a xenon arc lamp at 25 $\pm$ 1°C for up to 42 hours. Oxadiazon declined from an average of 98.68% of the recovered immediately posttreatment, to 42.46% at 26 hours. In the dark controls, no degradation was observed for 42 hours.

The degradates identified were RP36939 and RP37084, present at up to 4.8% and 11.5% of the applied radioactivity, respectively. Up to 20 degradates were isolated, present at <8% of the applied radioactivity. The registrant did not provide the chemical names for RP36939 and RP37084. The later one was a maximum of 11.5% of the applied at 42 hours (last test interval), when the level of oxadiazon had decreased to <28% of the applied. It is not likely that RP37084 would be formed in significantly higher quantities.

161-3 Photolysis on Soil (MRID# 41898201; Core)

[^{14}C]oxadiazon (phenyl ring-labeled), at 9.4-11.3 ppm, degraded slowly with a calculated half-life of 165 days on a sandy loam soil irradiated with xenon arc lamp intermitently at 25°C. There was no significant breakdown of the parent under non-irradiated conditions. In the irradiated samples, oxadiazon averaged 90.2% of the applied at day 0 posttreatment, and averaged 86.6% at day 30. In the dark samples, oxadiazon averaged 90.2% of the applied at day 0, and 90.8% at day 30. The following minor degradates were observed in small quantities.

- 2-tertiobutyl-4-(2,4-dichloro-5-hydroxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP25496), and
- 3-(2,4-dichloro-5-methoxyphenyl)-5-tertiobutyl-1,3,4-▲4-oxadiazolin-2-one (RP17272).

161-4 Photodegradation in Air (Waived)
163-2 Laboratory Volatility (Waived)
163-3 Field Volatility (Waived)

All three data requirements were waived, based on the relatively low vapor pressure ($1.0x10^{-6}$ mm Hg) and Henry's Law Constant (calc. $4.51x10^{-7}$ Atm· m^3/mol) of oxadiazon. EFED believes that this value is relatively low and that volatility of oxadiazon may not be an important route of dissipation for oxadiazon. This conclusion is further confirmed by the results of the Aerobic Soil Metabolism study (MRID# 42772801), which shows only a small fraction of the applied was volatilized after 1 year (see below).

162-1 Aerobic Soil Metabolism (MRID# 42772801; Core)

[^{14}C]-Oxadiazon (uniformly ring labeled) degraded slowly in sandy loam soil that was incubated aerobically in the dark at about 25°C and approximately 75% of soil water capacity at 0.33 bar for 1 year. The registrant-calculated initial half-life was well beyond the experimental time frame ($t_{½}$ = 841 days). Oxadiazon comprised 98.87-92.33% of the applied immediately posttreatment and decreased slowly to 72.11-76.47% of the applied after 365 days. Unextracted [^{14}C] residues, and volatilized [^{14}C] residues comprised 4.82% and 2.95% of the applied at 365 days, respectively.

Five degradates were identified:

- 3-(2,4-dichloro-5-methoxyphenyl)-5-tertiobutyl-1,3,4-▲4-oxadiazolin-2-one (RP17272)
- 2-(carboxy-2-propyl)-4-(2,4-dichloro-5-hydroxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP26471)
- 2-tertiobutyl-4-(2,4-dichloro-5-hydroxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP25496)
- 2-(2-carboxy-2-propyl)-4-(2,4-dichloro-5-isopropoxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP26449) and
- 1-trimethylacetyl-2-(2,4-dichloro-5-isopropoxyphenyl)hydrazine (RP26123).

These degradates were present at concentrations ≤1.51% of the applied throughout the study. Three other areas of radioactivity were isolated, but not identified, at ≤1% of the applied.

162-3 Anaerobic Aquatic Metabolism (MRID# 42773802: Supplemental)

[^{14}C] Oxadiazon (uniformly ring labeled) degraded slowly with an observed half-life of approximately 1 year in anaerobic (flooded plus nitrogen atmosphere) sandy loam soil that was incubated in the dark at about 25°C for 1 year; oxadiazon comprised 91.7-91.8% of the applied immediately posttreatment and decreased to 47.3-47.9% of the applied at 366 days. At 366 days, unextracted [^{14}C] residues were 2.47% of the applied and [^{14}C] volatiles totaled 0.02% of the applied.

Five degradates were identified:

- 2-(carboxy-2-propyl)-4-(2,4-dichloro-5-hydroxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP26471)
- 2-tertiobutyl-4-(2,4-dichloro-5-hydroxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP25496)
- 2-(2-carboxy-2-propyl)-4-(2,4-dichloro-5-isopropoxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP26449)

- 2,4-dichloroisopropoxybenzene (RP36227) and
- 1-trimethylacetyl-2-(2,4-dichloro-5-isopropoxyphenyl)hydrazine (RP26123).

All the degradates were present at concentrations ≤3.76% of the applied througout the experiments. In addition, one "cluster" of [^{14}C] residues was isolated from the floodwater at a maximum of 18.2% of the applied, and one was isolated from the soil at a maximum of 20.8% of the applied at 181 day. These [^{14}C] residues were not further characterized.

163-1 Mobility in Soil (MRID# 41889601; Core)

[^{14}C]-Oxadiazon (phenyl ring labeled), at 4 ppm showed a low mobility in soil leaching columns containing sand, loam, and two sandy loam soils. The material was either freshly applied (parent pesticide), or applied after 30 days of aerobic incubation.

A similar profile was observed in the aged and unaged soil columns. The majority of the radioactivity (≥80.5%) remained in the upper 0-6 inches of the 36 inches long columns, indicating a low mobility for parent oxadiazon in these soil. The amount of radiaoctivity recovered from the leachate was small (≤0.2%). Solvent extracts were shown to contain only parent compound. The total recoveries of radioactivity were 92.6-102.4%.

163-1 Mobility - Leaching and Adsorption/Desorption (MRID# 41898202; Supplemental)

Based on batch equilibrium studies, at nominal concentrations of 0.1-0.3 ppm and 25°C, [^{14}C]Oxadiazon demonstrated slight mobility in sand and sandy loam, and low mobility in a clay and silt loam. The Kd and Koc constants obtained from the Freundlich isotherms were as follows:

Table 1. Mobility of Oxadiazon		adsorption.		desorption	
Soil type	%OC	Kd	Koc	Kd	Koc
silt loam	1.2	16.91	1409	21.35	1779
clay	1.2	22.83	1903	51.72	4310
sandy loam	0.4	11.39	2848	41.00	10250
sand	0.25	8.17	3268	10.34	`4136

The soil treatment included grinding in a grist mill. It is not known what is the particle size distribution. The particle size of the soil is a determinant of its adsortivity. A cursory revision of the DER for this study indicates that 1/n values were not reported for any soil type.

164-1 Terrestrial Field Dissipation (MRID# 41767401; Core)

Oxadiazon slowly dissipated from two field plots located in San Juan Bautista, California (sandy loam soil)

and Clayton, North Carolina (loamy sand) and planted with Junipers and Azaleas, respectively. The plots were treated with oxadiazon at 4.48 kg ai/ha (4.06 lb ai/A). The registrant-calculated initial half-life of oxadiazon in the California site was 65 days, and 40 days in the North Carolina site. The dissipation rate was near zero during the winter season in both locations. Oxadiazon appears to persist over time. In the 0- to 15-cm soil depth of the California site, oxadiazon was 1.80-3.60 ppm immediately posttreatment and decreased to 0.08-0.18 ppm at 12-16 months. In the North Carolina site oxadiazon was 1.08-2.05 ppm immediately posttreatment and decreased to 0.02-0.43 ppm at 12-16 months. In the 15- to 30-cm soil depth of both plots, oxadiazon was ≤0.12 ppm through 2 months and ≤0.01 ppm thereafter.

Generally, oxadiazon residues were detected only in the upper 30 cm of the soil, with occasional small detections in the 15- to 30-cm soil depth. The degradates

- 3-(2,4-Dichloro-5-methoxyphenyl)-5-tertiobutyl-1,3,4-▲4-oxadiazolin-2-one (RP-17272) and
- 2-(2-Carboxy-2-propyl)-4-(2,4-dichloro-5-isopropoxyphenyl)-5-oxo-1,3,4-oxadiazolin (RP-26449)

were each present at ≤0.02 ppm in the 0- to 15-cm soil depth, and were not detected in the deeper soil layers. Total irrigation plus rainfall during the study period was 14.03 cm in the California site, and 20.03 cm in the North Carolina site.

165-4 Bioaccumulation in Fish (MRID# 42226701; Core)

Oxadiazon residues accumulated in bluegill sunfish continuously exposed to 8.8 ug/L of oxadiazon, with average bioconcentration factors of 368x for the edible tissues (muscle), 2239x for the nonedible tissues (viscera), and 1111x for the whole fish. Maximum mean [^{14}C]residue concentrations were 4.26 ug/g for the edible tissues, 26.83 ug/g for the nonedible tissues, and 11.94 ug/g for whole fish. Steady state concentrations were observed within 3 days of exposure. Depuration was rapid, with an observed half-life of about 1 day; by day 3 of the depuration period, 83% of the accumulated [^{14}C]residues had been eliminated from whole fish, and by day 14, >97% were eliminated.

Parent [^{14}C]oxadiazon was detected only once in the fish inedible tissues on day 14; three degradates were identified in the fish samples:

- 5-(1-hydroxymethyl-1-methylethyl)-3-(2,4-dichloro-5-isopropoxyphenyl)-1,3,4-oxadiazol-2(3H)-one (M8), which was 15.8-24.6% of the [^{14}C] residues extracted from the edible fish;
- An ether glucuronide conjugate of M8 (chemical name not provided), which was 25.8-31.6% of the [^{14}C] residues extracted from the edible fish; and
- 5-(1-hydroxymethyl-1-methylethyl)-3-(2,4-dichloro-5-hydroxyphenyl)-1,3,4-oxadiazol-2(3H)-one (M10), which was 8.5-13.4% of the [^{14}C] residues extracted from the edible fish.

875.2100 Transferable Oxadiazon Residues on Turf Treated with the Product in the Granular Formulation (MRID# 44995501; supplemental)

EFED had available a review by Versar, Inc., a contractor for HED studies. This study and the review were prepared as a requirement of the Health Effects Division. Only some highlights of the study are

mentioned here for information only, since EFED investigated the usefulness of the study for modeling purposes.

This test was performed with the granular formulation of oxadiazon. Samples were taken with cotton cloth sheets, which were exposed to a large turf area. These samples were taken at various test intervals, starting from prior to application, from three geographical locations. It appears that the registrant did not intend to compare the actual amount of oxadiazon residues present on and in turf, compared to the amount present in the cotton cloth. The registrant may have developed that information, but it was not available to EFED at this time.

The reported LOQ was 25 µg/sample, while the LOD was not provided. Several results were less than the LOQ.

The authors intended also to report the degradates RP25496+RP17272 (together), and RP26449. These degradates, however, were not detected in any sampling interval through the study.

Half-life of the transferable residues may be around 2-7 days for the granular formulation. By no means that would definitely mean that 7 days would be representative of the half-life of oxadiazon in the turf because there is no evidence that the methodology used was in some way quantitatively measuring the total levels of oxadiazon in the foliage. For the purpose of running EFED models, this study can only be regarded at best as supplemental.

875.2100 Transferable Oxadiazon Residues on Turf Treated with the Product in the Liquid Formulation (MRID# 44995502; supplemental)

EFED had available a review by Versar, Inc., a contractor for HED studies. This study and the review were prepared as a requirement of the Health Effects Division. Only some highlights of the study are mentioned here for information only, since EFED investigated the usefulness of the study for modeling purposes.

The product was formulated in Wettable Soluble Packets (of powder containing oxadiazon at about 2% of a.i.). The product was applied at 3 lb a.i./A. Samples were taken in triplicate with cotton cloth sheets, which were exposed to a large turf area. These samples were taken at various test intervals, starting from prior to application, from two geographical locations. Sampling occurred between March 26 and April 8, 1999. It appears that the registrant did not intend to compare the actual amount of oxadiazon residues present on turf and in turf, compared to the amount present in the cotton cloth. The registrant may have developed that information, but it was not available to EFED at this time.

The reported LOQ was 25 µg/sample, while the LOD was not provided. Several results were less than the LOQ. In addition, the authors intended also to report the degradates RP25496+RP17272 (together), and RP26449. It appears, however, that these degradates were not detected in any sampling interval through the study.

In the California site, the data was very variable, and it was judged unreliable by the authors of the study. The review does not offer the author's detailed rationale with respect to this invalidation. On the other hand, a study conducted in Georgia, yielded most samples at > LOQ, although the range of the actual results was several orders of magnitude larger than range of the fortified samples. Based on the results of the 27 samples available, the half-life was about 2.3 days, with a correlation coefficient (R^2) of 0.7. By no means that would definitely mean that 2 days would be representative of the half-life of oxadiazon in the turf because there is no evidence that the methodology used was in some way quantitatively measuring the total levels of oxadiazon in the foliage. Furthermore, out of two studies conducted with the liquid formulation, only one produced results with acceptable concentrations above the LOQ. EFED believes that for the purpose of running EFED models, this study can only be regarded at best as informative, and, for the safety of the public, the default value of 35 days should be used.

APPENDIX C: ECOLOGICAL TOXICITY DATA

Toxicity testing reported in this section is not representative of the wide diversity of terrestrial and aquatic organisms in the United States. Two surrogate bird species, the bobwhite quail and the mallard duck, are used for the 680 plus species of birds found in this country. For mammals, acute studies are usually limited to the Norway rat or the house mouse. Reptiles are not tested, as these are assumed to be subject to similar toxicological effects as birds. Of approximately 100,000 species of insects, spiders, and other terrestrial arthropods, toxicity tests are usually required only for the honey bee. Only two surrogate fish species (rainbow trout and bluegill sunfish) are used to represent the over 2,000 species of freshwater fish found in this country. Amphibians are not tested, as these are assumed to be subject to similar toxicological effects as fish. One crustacean, the water flea, is used to represent all freshwater invertebrates. Estuarine/marine animal acute toxicity testing is usually limited to a crustacean, a mollusk, and a fish. Testing on aquatic plants is limited to one species of vascular plant (duckweed) and four species of algae and diatoms.

Toxicity to Terrestrial Organisms

Birds, Acute, Subacute and Chronic

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of oxadiazon to birds. The avian oral LD_{50} is an acute, single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of birds. The preferred test species is either the mallard duck, a waterfowl, or bobwhite quail, an upland gamebird. The TGAI is administered by oral intubation to adult birds, and the results are expressed as LD_{50} milligrams (mg) active ingredient (a.i.) per kilogram (kg). Toxicity category descriptions are as follows:

If the LD_{50} is *less than 10 mg a.i./kg*, then the test substance is *very highly toxic*.
If the LD_{50} is *10-to-50 mg a.i./kg*, then the test substance is *highly toxic*.
If the LD_{50} is *51-to-500 mg a.i./kg*, then the test substance is *moderately toxic.*
If the LD_{50} is *501-to-2,000 mg a.i./kg*, then the test substance is *slightly toxic.*
If the LD_{50} is *greater than 2,000 mg a.i./kg*, then the test substance is *practically nontoxic.*

Study results are in the table below.

Table C.1. Avian Acute Oral Toxicity

Species	% ai	LD_{50} (mg/kg)	Toxicity Category	MRID/ Lab/Year	Classification
Northern Bobwhite *(Colinus virginianus)*	99.1	6000	practically nontoxic	111807 (also under 112622) Biometric Testing, Inc. 1971	Supplemental[1]
Mallard *(Anas platyrhynchos*)	99.1	1040	slightly toxic	111806 Biometric Testing, Inc. 1971	Supplemental[1]
Northern Bobwhite *(Colinus virginianus)*	97.49	>2150 (no bird mortality)	practically nontoxic	41610101 Bio-Life Associates, Ltd 1990	Core

[1] studies are scientifically sound; although deemed satisfactory for registration of oxadiazon in the early 1970's, EFED required a new study in 1991under Phase IV Reregistration.

Based on results of the above studies, oxadiazon may be categorized slightly to practically nontoxic to birds on an acute oral basis. The guideline 71-1(a) is fulfilled (MRID 41610101).

Two dietary studies using the TGAI are required to establish the toxicity of oxadiazon to birds. These avian dietary LC_{50} tests, using the mallard duck and bobwhite quail, are acute, eight-day dietary laboratory studies designed to estimate the quantities of toxicant required to cause 50% mortality in the two respective test populations of birds. The TGAI is administered by mixture to juvenile birds' diets for five days followed by three days of "clean" diet, and the results are expressed as LC_{50} parts per million (ppm) active ingredient (a.i.) in the diet. Toxicity category descriptions are as follows:

If the LC_{50} is *less than 50 ppm a.i.*, then the test substance is *very highly toxic*.
If the LC_{50} is *50-to-500 ppm a.i.*, then the test substance is *highly toxic*.
If the LC_{50} is *501-to-1,000 ppm a.i.*, then the test substance is *moderately toxic.*
If the LC_{50} is *1001-to-5,000 ppm a.i.*, then the test substance is *slightly toxic.*
If the LC_{50} is *greater than 5,000 ppm a.i.*, then the test substance is *practically nontoxic.*

Study results are tabulated below.

Table C.2. Avian Subacute Dietary Toxicity

Species	% ai	LC_{50} (ppm)	Toxicity Category	MRID/Lab/ Year	Study Classification
Bobwhite Quail *(Colinus virginianus*)	97.49	>5,000 (no bird mortality)	practically nontoxic	41610102 Bio-Life Associates, Ltd 1990	Core
Mallard Duck *(Anas platyrhynchos*)	97.49	>5000 (no bird mortality)	practically nontoxic	41610103 Bio-Life Associates, Ltd 1990	Core

Based on results of the above studies, oxadiazon may be characterized practically nontoxic to birds on a subacute basis. The guideline 71-2(a) for bobwhite (MRID 41610102) and 71-2(b) for mallard duck (MRID 41610103) are fulfilled.

Avian reproduction tests are designed to estimate the quantity of toxicant required to adversely affect the reproductive capabilities of a test population of birds. The TGAI is administered by mixture to breeding birds' diets throughout their breeding cycle. Test birds are approaching their first breeding season and, generally, are 18-to-23 weeks old. The onset of the exposure period is at least 10 weeks prior to egg laying. Exposure period during egg laying is generally 10 weeks with a withdrawal period of three additional weeks if reduced egg laying is noted. Results are expressed as No Observed Adverse Effect Concentration (NOAEC) and various observable effect levels, such as the Lowest Observable Adverse Effect Concentration (LOAEC), quantified in units of parts per million of active ingredient (ppm) in the diet. Study results are tabulated below .

Table C.3. Avian Chronic Toxicity

Species/ Study Duration	% ai	NOAEC/ LOAEC (ppm)	LOAEC Endpoints	MRID/Lab/ Year	Classification
Mallard Duck *(Anas platyrhynchos)* 20 weeks	97.49	>1000 (highest dose tested)/ LOAEC not determined	not determined	41993201 Bio-Life Associates, Ltd 1991	Supplemental[1]
Northern bobwhite *(Colinus virginianus)* 21 weeks	97.49	500/1000	mortality among adult females	41993202 Bio-Life Associates, Ltd 1991	Core

[1] study was classified supplemental because a NOAEC was not established.

Based on the results of the bobwhite reproduction study, the ingestion of oxadiazon at levels up to 1,000 ppm, the highest dose concentration tested, had no effect on any reproductive parameter or viability of F_1 the offspring (reproductive NOAEC >1000 ppm). However, mortality among females at that level was quite high (33%). The study authors stated that due to the inconsistency and lack of dose-related pathology observations in birds found dead or sacrificed at study termination, the pathology observations were attrbuted to factors other than the test substance. EFED, in the absence of information on the cause of the deaths, considered the mortality attributable to treatment. The chronic NOAEC was set at 500 ppm. The guideline 71-4(a) is fulfilled (MRID 41993202).

The avian reproduction study using mallard resulted in a NOAEC greater than 1000 ppm, the highest dose tested. This study was classified supplemental because a NOAEC was not established. Although the study is classified supplemental, it does not have to be repeated because (1) the bobwhite was more sensitive in testing, and (2) the highest dose tested is greater than the highest estimated environmental concentration for the highest application rate (turf; 4 lb ai/A; maximum Fletcher value 240 x 4 = 960 ppm). The guidelines 71-4(a) for the bobwhite (MRID 41993202) and 71-4(b) for the mallard (MRID 41993201) are considered fulfilled.

Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. The acute toxicity values below were taken from HED's Tox One-Liners. Chronic toxicity information was obtained from the Health Effects Division Hazard Identification Assessment Review Committee (HIARC report HED DOC. NO. 014469; February 8, 2001).

Table C.4. Mammalian Acute Toxicity

Species	% ai	Test Type	LD_{50} (mg/kg)	Toxicity Category)	MRID
laboratory rat (*Rattus norvegicus)*	97.5	oral - single dose	>5,000 (combined sexes)	practically nontoxic	41866501

Table C.5. Mammalian Chronic Toxicity

Species	% ai	Test Type	NOAEC/LOAEC (ppm)	Affected Endpoints	MRID
laboratory rat (*Rattus norvegicus)*	96.6	1- generation reproduction study (range-finding)	200/400	inactive mammary tissue and fetal/pup death	41239801
laboratory rat (*Rattus norvegicus)*	96.6	2-generation reproduction study (main study)	200/ >200	no difference in reproductive parameters	41239801

With a rat LD50 >5,000 mg /kg, oxadiazon may be characterized practically nontoxic to mammals on an acute oral basis. The rat reproduction study (one generation range-finding test) showed a NOAEC/LOAEC of 200/400 ppm. Chronic effects included inactive mammary tissue and fetal/pup death.

Insect Acute Contact

A honey bee acute contact study using the TGAI is required to support outdoor uses. The acute contact LD_{50}, using the honey bee, *Apis mellifera*, is an acute contact, single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of bees. The TGAI is administered by one of two methods: whole body exposure to technical pesticide in a nontoxic dust diluent; or, topical exposure to technical pesticide via micro-applicator. The median lethal

dose (LD_{50}) is expressed in micrograms of active ingredient per bee (*u*g a.i./bee). Toxicity category descriptions are as follows:

> If the LD_{50} is *less than 2* µg a.i./bee, then the test substance is *highly toxic*.
> If the LD_{50} is *2 to less than 11* µg a.i./bee, then the test substance is *moderately toxic*.
> If the LD_{50} is *11* µg a.i./bee or *greater*, then the test substance is *practically nontoxic*

Study results are tabulated below.

Table C.6. Nontarget Insect Acute Contact Toxicity

Species	% ai	LD50 (μg/bee)	Toxicity Category	MRID/Lab/ Year	Study Classification
Honey bee (Apis mellifera)	95.9	> 25	practically nontoxic	42468301 California Agricultural Research Inc. 1992	Core

The LD_{50} for oxadiazon is greater than 25 ug per bee, characterizing oxadiazon practically nontoxic to bees. The guideline (141-1) is fulfilled (MRID 42468301).

Insect Residual Contact

Honey bee toxicity of residues on foliage study is required on an end-use product for any pesticide intended for outdoor application when the proposed use pattern indicates that honey bees may be exposed to the pesticide and when the formulation contains one or more active ingredients having an acute contact honey bee LD_{50} which falls in the moderately toxic or highly toxic range. Since oxadiazon is practically nontoxic to honey bees a honey bee toxicity of residues on foliage (Guideline 141-2) is not required.

Terrestrial Plant Testing

The data were deemed inadequate for determining the EC_{25}/NOAEC values of the most sensitive species (Reference: D166982; 1995 memo to SRRD requesting repeat of all ten species due to very poor study with numerous deficiencies and guideline deviations). To date, the studies have not been submitted to EFED.

Aquatic Organism Toxicity

Toxicity to Freshwater Organisms

Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of oxadiazon to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a

warmwater fish). Toxicity category descriptions are as follows:

If the LC_{50} is *less than 0.1 ppm a.i.*, then the test substance is *very highly toxic*.
If the LC_{50} is *0.1-to-1.0 ppm a.i.*, then the test substance is *highly toxic*.
If the LC_{50} is *greater than 1 and up through 10 ppm a.i.*, then the test substance is *moderately toxic*.
If the LC_{50} is *greater than 10 and up through 100 ppm a.i.*, then the test substance is *slightly toxic.*
If the LC_{50} is *greater than 100 ppm a.i.*, then the test substance is *practically nontoxic.*

Study results are tabulated below.

Table C.7. Freshwater Fish 96-hr Acute Toxicity

Species/ Flow-through or Static	% ai	LC_{50} (ppm)	Toxicity Category	MRID /Lab/ Year	Study Classification
Bluegill sunfish *(Lepomis macrochirus)* /static	97.4	0.88 (nominal)	highly toxic	McCann / 1977	Supplemental[1]
Bluegill sunfish *(Lepomis macrochirus* / flow-through	95.9	1.2 (measured)	moderately toxic	42350601 ABC Labs., Inc. 1992	Core
Rainbow Trout *(Oncorhynchus mykiss)*/static	97.4	1.05 (nominal)	moderately toxic	McCann /1977	Supplemental[1]
Rainbow Trout *(Oncorhynchus mykiss)* / flow-through	95.9	1.2 (measured)	moderately toxic	42330401 ABC Labs, Inc. 1992	Core

[1] EFED considers McCann studies as scientifically sound and useful for risk assessment purposes, even though studies do not follow current protocols and raw data are not available for verification of results.

Based on the above studies, oxadiazon may be characterized moderately to highly toxic to freshwater warmwater fish on an acute basis. The guideline 72-1(a) for bluegill is fulfilled (MRID 42350601 and McCann study). Oxadiazon may be characterized as moderately toxic to freshwater coldwater fish on an acute basis. The guideline 72-1(c) for rainbow trout is fulfilled (MRID 42350401 and McCann study).

Freshwater Fish, Chronic

A freshwater fish early life-stage test using the TGAI is required for oxadiazon because the end-use product may be transported to water from the intended use site, and an acute aquatic toxicity value is less than 1 ppm. Acceptable freshwater test species are rainbow trout, brook trout, coho salmon, chinook, bluegill, brown trout, lake trout, northern pike, fathead minnow, white sucker and channel catfish. The fish early life-stage is a laboratory test designed to estimate the quantity of toxicant required to adversely effect

the reproductive capabilities of a test population of fish. The TGAI is administered into water containing the test species, providing exposure throughout a critical life-stage, and the results are expressed as a No Observed Adverse Effect Concentration (NOAEC) and LOAEC (Lowest Observed Adverse Effect Concentration). Testing results are summarized below.

Table C.8. Freshwater Fish Chronic Toxicity

Species/Static or Flow-through Study Duration	% ai	NOAEC/LOAEC (ppb)/ (measured/nominal)	Endpoints Affected	MRID/Lab/ Year	Study Classification
Rainbow trout (*Oncorhynchus mykiss*)	>98% Radiopurity	0.88/1.7 (measured)	egg hatch ability	41811601 Analytical Bio-chemistry Labs, Inc. 1991	Core
Fathead minnow *(Pimephales promelas)* / flow-through/ 48 days	>98.5 Radiopurity	33 /84 (measured)	growth (length of fry)	42921601 Analytical Bio-chemistry Labs, Inc. 1993	Core

The rainbow trout was found to be more sensitive than the fathead minnow in fish early life stage testing. The guideline 72-4(a) for early life-stage fish testing is fulfilled.

Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of oxadiazon to aquatic invertebrates. The preferred test organism is Daphnia magna, but early instar amphipods, stoneflies, mayflies, or midges may also be used Study results are tabulated below.

Table C.9. Freshwater Invertebrate Acute Toxicity (48-hour)

Species/Static or Flow-through	% ai	EC_{50} (ppm)/ (nominal/measured)	Toxicity Category	MRID/Lab/ Year	Study Classification
Daphnid *(Daphnia magna)*/ static	97.4	2.18 (nominal)	moderately toxic	McCann /1977	Supplemental[1]
Daphnid *(Daphnia magna)* / flow-through	95.9	>2.4 (measured)	moderately toxic	42331801 Analytical bio-chemistry Labs., Inc. 1992	Core

[1] EFED considers McCann studies as scientifically sound and useful for risk assessment purposes.

Based on results of the above studies, oxadiazon may be categorized moderately toxic to freshwater aquatic invertebrates on an acute basis. The guideline 72-2(a) is fulfilled (MRID 42331801 and McCann study).

Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test using the TGAI is required because the end-use product is expected to be transported to water from the intended use site, and an aquatic acute LC_{50} is less than 1.0 ppm. The preferred test species is *Daphnia magna*.

Table C.10. Freshwater Invertebrate Chronic

Species/Static or Flow-through/ Duration	% ai	NOAEC/LOAEC ppb (nominal/measured)	Endpoints Affected	MRID/Lab/ Year	Study Classification
Daphnid *(Daphnia magna)*/ flow-through/ 21-day	97.49	30 / 55 (measured)	survival; adult mean length; mean time in days to first brood and young/adult/ reproduction day	41784301 Analytical Bio-chemistry Labs., 1991	Core

Based on the results of a 21-day daphnid chronic test survival with effects on adult growth, time in days to first brood and number of young/adult/reproduction day at a LOAEL of 55 ppb , the NOAEC is 30 ppb. The guideline 72-4(b) for invertebrate life-cycle testing is fulfilled (MRID 41784301).

Toxicity to Estuarine and Marine Organisms

Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine and marine fish using the TGAI is required for oxadiazon because the end-use product may reach the marine/estuarine environment. The preferred test organism is the sheepshead minnow. Study results are tabulated below.

Table C.11. Estuarine/Marine Fish Acute Toxicity

Species/static or flowthrough	% a.i.	LC_{50}) ppm/ (measured/nominal)	Toxicity Category	MRID/Lab/ Year	Classification
Sheepshead minnow/ *(Cyprinodon varie*gatus)/ flow-through	95.9	1.5 (measured)	moderately toxic	42615801 Springborn Labs, Inc. 1992	Core

Based on results of the above study, oxadiazon may be categorized moderately toxic to estuarine fish on an acute basis. The guideline 72-3(a) is fulfilled (MRID 42615801).

Estuarine and Marine Fish, Chronic

No data are available.

Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for oxadiazon because the end-use product may reach the marine/estuarine environment. The preferred test species are mysid shrimp and eastern oyster. Study results are tabulated below.

Table C.12 . Estuarine/Marine Invertebrate Acute Toxicity

Species/Static or Flow-through	% a.i.	96-hour EC_{50} (ppm)/ (measured/nominal)	Toxicity Category	MRID/Lab/ Year	Study Classification
Eastern oyster *(Crassostrea virginica)*/flow-through (shell deposition)	95.9	0.7 (measured)	highly toxic	42570301 Springborn 1992	Supplemental[1]
Mysid *(Americamysis bahia)*/flow-through	95.9	0.27 (measured)	highly toxic	42615802 Springborn 1992	Core

[1] classified supplemental because average growth in controls was less than 2 mm.

Based on the results of the above studies, oxadiazon is considered to be highly toxic to estuarine invertebrates on an acute basis.

Although the oyster study is classified supplemental, the study does not need to be repeated, since the mysid was the more sensitive of the two species, and will be used for risk assessment purposes (Reference: D182582; 3/16/95). The guideline 72- 3(b) for the oyster is considered fulfilled (MRID. 42570301). The guideline 72-3(c) for the mysid is fulfilled (MRID 42615802).

Estuarine and Marine Invertebrate, Chronic

No data are available. The guideline 72-4(b) for the estuarine/marine invertebrate life cycle is not fulfilled.

Aquatic Plants

Tier I or Tier II aquatic plant growth testing using the TEP is required for fungicides. The recommendation is for five species: freshwater green alga (*Selenastrum capricornutum*), duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), blue-green algae (*Anabaena flos-aquae*), and a freshwater diatom. Results of testing with the TGAI are below.

Table C.13. Nontarget Aquatic Plant Toxicity (Tier II)

Species/duration	% A. I.	EC_{50}/NOAEC (ppb)	MRID No. Author/year	Classification[1]
duckweed *(Lemna gibba)*/ 14 day	97.49	41 / <8 (measured)	41610107 Springborn Laboratories Inc. 1990	Supplemental[1]
freshwater green algae *(Selenastrum capricornutum)* /120 hrs.	97.49	8 /5.6 (measured)	41610108 Springborn Laboratories Inc. 1990	Core
marine diatom *(Skeletonema costatum)*/120 hrs.	97.49	5.2 / 1.4 (measured)	41610105 Springborn Laboratories Inc. 1990	Core
freshwater diatom *(Navicula pelliculosa)*/120 hrs.	97.49	126 / 27 (measured)	41610106 Springborn Laboratories Inc. 1990	Core
blue-green algae (*Anabaena flos-aquae*)	97.49	NOAEC > 3.7 mg/L	42659001 Springborn Laboratories Inc. 1990	Supplemental

[1] the study was classified supplemental primarily because the exposure concentrations used in the test were too high to establish a NOAEC.

With an EC50 of 5.2 ppb, the marine diatom appears to be the most sensitive non-vascular aquatic plant species tested.

Guideline 123-2 (Tier II) is fulfilled for the five species required (MRIDs 41610107, 41610108, 41610105, 41610106, 42659001). Although the duckweed study and the blue-green algae study were classified supplemental, they do not have to be repeated since adequate information was provided for risk assessment purposes.

APPENDIX D: TERRESTRIAL MODEL RUNS

ELL-Fate Version 1.2 July 19, 2001
Developed by Laurence Libelo. February, 1999

This spreadsheet based model calculates the decay of a chemical applied to foliar surfaces for single or multiple applications. It uses the same principle as the batch code models FATE and TERREEC for calculating terrestrial estimates exposure (TEEC) concentrations on plant surfaces following application.

A first order decay assumption is used to determine the concentration at each day after initial application based on the concentration resulting from the initial and additional applications. The decay is calculated by from the first order rate equation:

$$CT = Cie\text{-}kT$$

or in integrated form:

$$\ln (CT/Ci) = kT$$

Where

CT = concentration at time T = day zero.
Ci = concentration, in parts per million (PPM) present initially (on day zero) on the surfaces.

Ci is calculated based on Kenaga and Fletcher by multiplying the Ci is calculated based on the Kanaga nomogram (Hoerger and Kenaga, (1972) as modified Fletcher (1994). For maximum concentration the application rate, in pounds active ingredient per acre, is multiplied by 240 for Short Grass, 110 for Tall Grass, and 135 for Broad leafed plants/insects and 15 for Seeds. Additional applications are converted from pounds active ingredient per acre to PPM on the plant surface and the additional mass added to the mass of the chemical still present on the surfaces on the day of application.

k = degradation rate constant determined from studies of hydrolysis, photolysis, microbial degradation etc. Since degradation rate is generally reported in terms of half-life the rate constant is calculated from the input half-life ($k = \ln 2/T1/2$) instead of being input directly. Choosing which processes controls the degradation rate and which half-life to use in terrestrial exposure calculations is open for debate and should be done by a qualified scientist.

T = time, in days, since the start of the simulation. The initial application is on day 0. The simulation is hardwired to run for 365 days.

The program calculates concentration on each type of surface on a daily interval for one year.

The maximum concentration during the year and the average concentration during the first 56 days are calculated.

The inputs used to calculate the amount of the chemical present are in highlighted in yellow on the spread sheet. Outputs are in blue. The inputs required are:

Application Rate: The maximum label application rate (in pounds ai/acre)
Half-life: The degradation half-life for the dominate process(in days)
Frequency of Application: The interval between repeated applications, from the label (in days)
Maximum # Application per year: From the label

The calculated concentrations are used to calculate Avian and Mammalian RQ values. The maximum calculated concentration is divided by user input values of Chronic No Observable Adverse Effects Level and acute LC50 to give RQs for each plant type.

The rat LC 50 is calculated by dividing the mammalian LD 50 by 0.05 (to correct for actual food consumption)

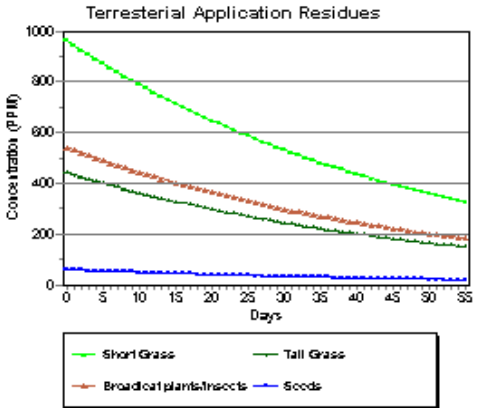
For 15g, 35g and 1000 g mammals the RQ values are calculated by dividing the maximum concentration for each surface by the LD 50 or NOAEL corrected for consumption (0.95, 0.66 and .15 body wt. for herbivores and insectivores and 0.21, 0.15 and 0.3 body wt. for granivore)

The number of days that the input value of Chronic No Observable Adverse Effects Level and acute LC50 are exceeded in the first 56 days is calculated by comparing the input value to the calculated concentration.

A graph of concentration on each plant surface vs time is plotted and a "level of concern" line can be added at a user specified level.

The maximum single application which can be applied and not exceed the toxicity input values if calculated by dividing the input value by the Kenaga maximum concentration for Short Grass (240).

Chemical Name:	**Oxadiazion**
Use	flax
Formulation	EC



Inputs

Application Rate	4	lbs a.i./acre
Half-life	35	days
Application Interval	182	days
Maximum # Apps./Year	2	

Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)	
Short Grass	986.12	585.83	
Tall Grass	451.97	268.51	# days
Broadleaf plants/Insects	554.69	329.53	Exceeded
Seeds	61.63	36.61	on short grass (in first 56)

Avian

Acute LC_{50} (ppm)	5000	0	
Chronic NOAEC (ppm)	500	33	

Max Single Application which does NOT exceed

Acute RQ	Chronic RQ (Max. res. mult. apps.)		
Short Grass	**0.20**	**1.97**	
Tall Grass	**0.09**	**0.90**	# days
Broadleaf plants/Insects	**0.11**	**1.11**	Exceeded
Seeds	**0.01**	**0.12**	on short grass (in first 56)

Avain Acute	20.833
Avian Chronic	2.083 (lb a.i.)
Mammalian Acute	138.89
Mammalian Chronic	5.56

Mammalian

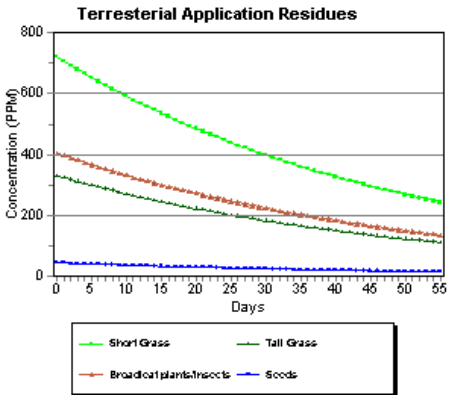
Acute LD_{50} (mg/kg)	5000	0	Rat Calculated LC_{50} (ppm)	100000
Chronic NOAEL (mg/kg)	200	56		

	15 g mammal		35 g mammal		1000 g mammal			
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Rat Acute Dietary RQ	Rat Chronic Dietary RQ
Short Grass	0.19	4.68	0.13	3.25	0.03	0.74	**0.01**	**4.93**
Tall Grass	0.09	2.15	0.06	1.49	0.01	0.34	**0.00**	**2.26**
Broadleaf plants/Insects	0.11	2.63	0.07	1.83	0.02	0.42	**0.01**	**2.77**
Seeds	0.01	0.29	0.01	0.20	0.00	0.05	**0.00**	**0.31**

Chemical Name:	**Oxadiazion**
Use	flax
Formulation	EC

Inputs

Application Rate	3	lbs a.i./acre
Half-life	35	days
Application Interval	182	days
Maximum # Apps./Year	2	



Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)	
Short Grass	739.59	439.37	
Tall Grass	338.98	201.38	# days
Broadleaf plants/Insects	416.02	247.15	Exceeded
Seeds	46.22	27.46	on short grass (in first 56)

Avian	Acute LC_{50} (ppm)	5000	0			
	Chronic NOAEC (ppm)	500	19			
				Max Single Application which does NOT exceed		
	Acute RQ	Chronic RQ (Max. res. mult. apps.)		Avain Acute	20.833	
				Avian Chronic	2.083	(lb a.i.)
Short Grass	**0.15**	**1.48**				
Tall Grass	**0.07**	**0.68**	# days	Mammalian Acute	138.89	
Broadleaf plants/Insects	**0.08**	**0.83**	Exceeded	Mammalian Chronic	5.56	
Seeds	**0.01**	**0.09**	on short grass (in first 56)			

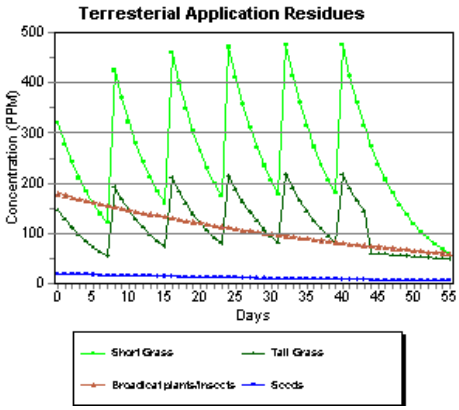
Mammalian	Acute LD_{50} (mg/kg)	5000	0	Rat Calculated LC_{50} (ppm)	100000
	Chronic NOAEL (mg/kg)	200	56		

	15 g mammal		35 g mammal		1000 g mammal			
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Rat Acute Dietary RQ	Rat Chronic Dietary RQ
Short Grass	0.14	3.51	0.10	2.44	0.02	0.55	**0.01**	**3.70**
Tall Grass	0.06	1.61	0.04	1.12	0.01	0.25	**0.00**	**1.69**
Broadleaf plants/Insects	0.08	1.98	0.05	1.37	0.01	0.31	**0.00**	**2.08**
Seeds	0.01	0.22	0.01	0.15	0.00	0.03	**0.00**	**0.23**

Chemical Name:	**Oxadiazion**
Use	flax
Formulation	EC

Inputs

Application Rate	1.33	lbs a.i./acre
Half-life	5	days
Application Interval	8	days
Maximum # Apps./Year	6	



Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)	
Short Grass	475.72	194.79	
Tall Grass	218.04	89.28	# days
Broadleaf plants/Insects	267.59	109.57	Exceeded
Seeds	20.49	12.17	on short grass (in first 56)

Avian

Acute LC_{50} (ppm)	5000	0	
Chronic NOAEC (ppm)	500	0	

	Acute RQ	Chronic RQ (Max. res. mult. apps.)		
Short Grass	**0.07**	**0.66**		
Tall Grass	**0.03**	**0.30**	# days	
Broadleaf plants/Insects	**0.04**	**0.37**	Exceeded	
Seeds	**0.00**	**0.04**	on short grass (in first 56)	

Max Single Application which does NOT exceed	
Avain Acute	20.833
Avian Chronic	2.083 (lb a.i.)
Mammalian Acute	138.89
Mammalian Chronic	5.56

Mammalian

Acute LD_{50} (mg/kg)	5000	0	Rat Calculated LC_{50} (ppm)	100000
Chronic NOAEL (mg/kg)	200	24		

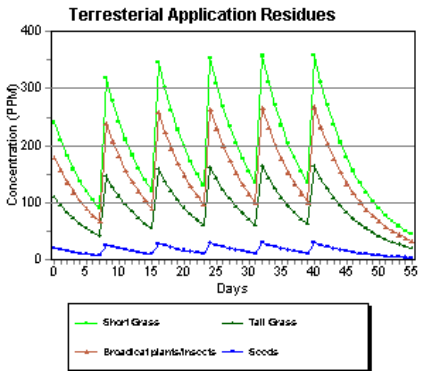
	15 g mammal		35 g mammal		1000 g mammal			
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Rat Acute Dietary RQ	Rat Chronic Dietary RQ
Short Grass	0.06	1.56	0.04	1.08	0.01	0.25	**0.00**	**1.64**
Tall Grass	0.03	0.71	0.02	0.50	0.00	0.11	**0.00**	**0.75**
Broadleaf plants/Insects	0.04	0.88	0.02	0.61	0.01	0.14	**0.00**	**0.92**
Seeds	0.00	0.10	0.00	0.07	0.00	0.02	**0.00**	**0.10**

units = weeks not days

Chemical Name:	**Oxadiazion**
Use	flax
Formulation	EC

Inputs

Application Rate	1	lbs a.i./acre
Half-life	5	days
Application Interval	8	days
Maximum # Apps./Year	6	



Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)	
Short Grass	357.68	257.05	
Tall Grass	163.94	117.82	# days
Broadleaf plants/Insects	201.20	144.59	Exceeded
Seeds	29.73	16.07	on short grass (in first 56)

Avian			
Acute LC_{50} (ppm)	5000	0	
Chronic NOAEC (ppm)	500	0	

	Acute RQ	Chronic RQ (Max. res. mult. apps.)	
Short Grass	**0.10**	**0.95**	
Tall Grass	**0.04**	**0.44**	# days
Broadleaf plants/Insects	**0.05**	**0.54**	Exceeded
Seeds	**0.01**	**0.06**	on short grass (in first 56)

Max Single Application which does NOT exceed

Avain Acute	20.833	
Avian Chronic	2.083	(lb a.i.)
Mammalian Acute	138.89	
Mammalian Chronic	5.56	

Mammalian		
Acute LD_{50} (mg/kg)	5000	0
Chronic NOAEL (mg/kg)	200	37

Rat Calculated LC_{50} (ppm): 100000

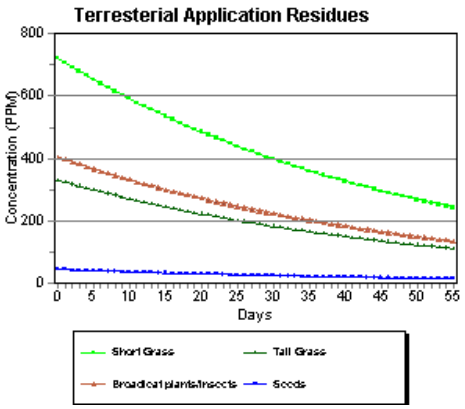
	15 g mammal		35 g mammal		1000 g mammal			
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Rat Acute Dietary RQ	Rat Chronic Dietary RQ
Short Grass	0.09	2.26	0.06	1.57	0.01	0.36	**0.00**	**2.38**
Tall Grass	0.04	1.04	0.03	0.72	0.01	0.16	**0.00**	**1.09**
Broadleaf plants/Insects	0.05	1.27	0.04	0.88	0.01	0.20	**0.00**	**1.34**
Seeds	0.01	0.14	0.00	0.10	0.00	0.02	**0.00**	**0.15**

units = weeks not days

Chemical Name:	**Oxadiazion**
Use	flax
Formulation	EC

Inputs

Application Rate	3	lbs a.i./acre
Half-life	35	days
Application Interval	162	days
Maximum # Apps./Year	2	



Outputs

	Maximum Concentration (PPM)	56 Day Average Concentration (PPM)	
Short Grass	749.11	439.37	
Tall Grass	343.34	201.38	# days
Broadleaf plants/Insects	421.37	247.15	Exceeded
Seeds	46.82	27.46	on short grass (in first 56)

Avian

Acute LC_{50} (ppm)	5000	0	
Chronic NOAEC (ppm)	500	19	

Acute RQ	Chronic RQ (Max. res. mult. apps.)		Max Single Application which does NOT exceed		
			Avain Acute	20.833	
			Avian Chronic	2.083	(lb a.i.)
Short Grass	**0.15**	**1.50**			
Tall Grass	**0.07**	**0.69**	# days	Mammalian Acute	138.89	
Broadleaf plants/Insects	**0.08**	**0.84**	Exceeded	Mammalian Chronic	5.56	
Seeds	**0.01**	**0.09**	on short grass (in first 56)		

Mammalian

Acute LD_{50} (mg/kg)	5000	0	Rat Calculated LC_{50} (ppm)	100000
Chronic NOAEL (mg/kg)	200	56		

	15 g mammal		35 g mammal		1000 g mammal			
	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Acute RQ (mult. apps)	Chronic RQ (Max. res.) mult. apps.)	Rat Acute Dietary RQ	Rat Chronic Dietary RQ
Short Grass	0.14	3.56	0.10	2.47	0.02	0.56	**0.01**	**3.75**
Tall Grass	0.07	1.63	0.05	1.13	0.01	0.26	**0.00**	**1.72**
Broadleaf plants/Insects	0.08	2.00	0.06	1.39	0.01	0.32	**0.00**	**2.11**
Seeds	0.01	0.22	0.01	0.15	0.00	0.04	**0.00**	**0.23**

APPENDIX E: DRINKING WATER CONCENTRATIONS

The Tier I Estimated Environmental Concentrations were calculated using the computer models FIRST (surface waters) and SCIGROW (ground waters). A copy from the electronic document generated by EFED appears next.
Drinking Water Memo:

U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

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OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

May 8, 2001
DPBarcode: D273599
PC Code 109001

MEMORANDUM

SUBJECT: Tier I Estimated Environmental Concentrations of Oxadiazon

FROM: José Luis Meléndez, Chemist
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

THROUGH: Mah T. Shamim, Ph.D., Chief
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

TO: Margaret Rice, Acting Branch Chief
Veronique LaCapra, CRM
and Tom Myers, Team Leader
Special Review and Reregistration Division (7508C)

This memo presents the Tier I Estimated Environmental Concentrations (EECs) for oxadiazon, calculated using FIRST (surface water) and SCIGROW (ground water) for use in the human health risk assessment. For surface water, the acute (peak) value is 246 ppb and the annual average value is 100 ppb. The groundwater screening concentration is 0.6 ppb. These values generally represent upper-bound estimates of the concentrations that might be found in surface water and groundwater due to the use of oxadiazon on turf, which is the major use of the chemical.

Background Information on FIRST:

FIRST is a new screening model designed to estimate the pesticide concentrations found in water for use in drinking water assessments. It provides high-end values on the concentrations that might be found in a small drinking water reservoir due to the use of pesticide. Like GENEEC, the model previously used for Tier I screening level, FIRST is a single-event model (one run-off event), but can account for spray drift from multiple applications. FIRST takes into consideration the so called Index Drinking Water Reservoir by representing a larger field and pond than the standard GENEEC scenario. The FIRST scenario includes a 427 acres field immediately adjacent to a 13 acres reservoir, 9 feet deep, with continuous flow (two turnovers per year). The pond receives a spray drift event from each application plus one runoff event. The runoff event moves a maximum of 8% of the applied pesticide into the pond. This amount can be reduced due to degradation on field and the effect of sorbing to soil. Spray drift is equal to 6.4% of the applied concentration from the ground spray application and 16% for aerial applications.

FIRST also makes adjustments for the percent crop area. While FIRST assumes that the entire watershed would not be treated, the use of a PCA is still a screen because it represents the highest percentage of crop cover of any large watershed in the US, and it assumes that the entire crop is being treated. Various other conservative assumptions of FIRST include the use of a small drinking water reservoir surrounded by a runoff-prone watershed, the use of the maximum use rate, no buffer zone, and a single large rainfall

Background Information on SCIGROW:

SCIGROW provides a groundwater screening exposure value to be used in determining the potential risk to human health from drinking water contaminated with the pesticide. Since the SCIGROW concentrations are likely to be approached in only a very small percentage of drinking water sources, i.e., highly vulnerable aquifers, it is not appropriate to use SCIGROW for national or regional exposure estimates.

SCIGROW estimates likely groundwater concentrations if the pesticide is used at the maximum allowable rate in areas where groundwater is exceptionally vulnerable to contamination. In most cases, a large majority of the use area will have groundwater that is less vulnerable to contamination than the areas used to derive the SCIGROW estimate.

Modeling Inputs and Results:

Tables 1 and 2 summarize the input values used in the model runs for FIRST 1.0 and SCIGROW, respectively. The lowest non-sand K_D was used in FIRST 1.0. The median K_{OC} value was used in SCIGROW. The available aerobic soil metabolism half-life for oxadiazon was extremely high. For FIRST, stability was assumed, while the extrapolated value of 841 days was used in SCIGROW. The modeling results associated with maximum allowable rate per year (4 lb ai/A applied twice at 6 months interval) are presented in Table 3. Attached to this memo are copies of the original printouts generated from FIRST and SCIGROW runs.

cc: Nancy McCarroll (HED)

Table 1. Environmental Fate and Other Input Parameters for the Estimation of Oxadiazon using FIRST

Parameter	Value	Source
Water Solubility (25°C)	1 ppm	One-Liner
Hydrolysis Half-Life (pH 7)	stable	MRID 41863603
Aerobic Soil Metabolism Half-Life (from 6 values)	essentially stable	MRID 42772801
Aerobic Aquatic Metabolism Half-life	not available	N/A
Aqueous Photolysis Half-Life	2.75 days	MRID 41897201
Soil/Water Partition Coefficient (Lowest non-sand K_d)	16.9	MRID 41898202
Pesticide is Wetted-In	Yes	Labels
PCA (turf)	0.87	Default
Depth of Incorporation (Broadcast)	0.0 inch	Labels

Table 2. Environmental Fate Input Parameters for the Estimation of Oxadiazon using SCIGROW.

Parameter	Value	Source
Organic Carbon Partition Coefficient (median K_{OC})	2376	MRID 41898202
Aerobic Soil Metabolism Half-Life (median)	841 days	MRID 42772801

Table 3. Modeling Results for Use of Oxadiazon on (Turf) Golf Courses

Parameter	Value	Source
Application Method	Ground Spray	Labels
Application Rate	4.0 lb a.i./A	Registrant
Applications Permitted per Year	2	Registrant***
Application Interval (days)	182	Registrant
FIRST 1.0 Peak Untreated Water Concentration	246 ppb	N/A
FIRST 1.0 Annual Average Untreated Water Concentration	100 ppb	N/A
SCIGROW Ground Water Concentration	0.6 ppb	N/A

***The Registrant supports multiple applications, at lower application rates.

RESULTS OBTAINED USING FIRST

RUN No. 1 FOR OXADIAZON ON Turf (Golf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	%CROPPED AREA	INCORP (IN)
4.000(8.000)	2 182	16.9	1.0	GROUND(6.4)	87.0	.0

FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (RESERVOIR)	PHOTOLYSIS (RES.-EFF)	METABOLIC (RESER.)	COMBINED (RESER.)
.00	0	N/A	2.75- 341.00	.00	341.00

UNTREATED WATER CONC (MICROGRAMS/LITER (PPB)) Ver 1.0 MAY 1, 2001

PEAK DAY (ACUTE) CONCENTRATION	ANNUAL AVERAGE (CHRONIC) CONCENTRATION
246.388	100.013

RESULTS OBTAINED USING SCIGROW

RUN No. 1 FOR OXADIAZON INPUT VALUES

APPL (#/AC) RATE	APPL. NO.	URATE (#/AC/YR)	SOIL KOC	SOIL AEROBIC METABOLISM (DAYS)
4.000	2	8.000	2376.0	841.0

GROUND-WATER SCREENING CONCENTRATIONS IN PPB

.592986

A= 836.000 B= 2381.000 C= 2.922 D= 3.377 RILP= 1.821
F= -1.130 G= .074 URATE= 8.000 GWSC= .592986

APPENDIX F: EXPOSURE AND RISK CHARACTERIZATION

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values: **RQ = exposure/toxicity**. To evaluate the potential risk to aquatic and terrestrial organisms from the use of Oxadiazon, risk quotients (RQs) are calculated from the ratio of estimated environmental concentrations (EECs) to ecotoxicity values.

For risk assessments, EFED used dosage rate information obtained from SRRD and BEAD. Since most of the use is on golf courses, turf was chosen to represent all sites.

Terrestrial and aquatic risk assessments were based on:

- 4 lb ai/A liquid and granular product at 1 and 2 applications per year with a six month reapplication interval
- 2.4 lb ai/A liquid product at 2 application per year with a six month reapplication interval

(NOTE: aquatic risk assessments did not include granular formulations)

RQs are then compared to levels of concern (LOC) criteria used by OPP for determining potential risk to nontarget organisms and the subsequent need for possible regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) **acute high** -- potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification, (2) **acute restricted use** -- the potential for acute risk is high, but it may be mitigated through restricted use classification, (3) **acute species** - the potential for acute risk to species is high, and regulatory action may be warranted, and (4) **chronic risk** - the potential for chronic risk is high, and regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to birds or mammals.

The ecotoxicity test values (measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC_{50} (aquatic plants and aquatic invertebrates) and (4) EC_{25} (terrestrial plants). Examples of toxicity test effect levels derived from long-term laboratory studies that assess chronic effects are: (1) LOAEC (birds, fish, and aquatic invertebrates) and (2) NOAEC (birds, fish and aquatic invertebrates). Generally, the most sensitive species tested are used. The NOAEC is used as the ecotoxicity test value in assessing chronic effects to birds, mammals, fish, and aquatic invertebrates.

Risk presumptions and the corresponding RQs and LOCs, are tabulated in Table 1.

Table 1. Risk presumptions for terrestrial organisms

Risk Presumption	RQ	LOC
Birds		
Acute High Risk	EEC[1]/LC_{50} or LD_{50}/sqft[2] or LD_{50}/day[3]	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Wild Mammals		
Acute High Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items

[2] $\frac{mg/ft^2}{LD_{50} * wt. of bird}$ [3] $\frac{mg\ of\ toxicant\ consumed/day}{LD_{50} * wt. of bird}$

Risk presumptions for aquatic organisms

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1

[1] EEC = (ppm or ppb) in water

Risk presumptions for plants

Risk Presumption	RQ	LOC
Plant Inhabiting Terrestrial and Semi-Aquatic Areas		
Acute High Risk	EEC^{1}/EC_{25}	1
Acute Species	EEC/EC_{05} or NOAEC	1
Aquatic Plants		
Acute High Risk	EEC^{2}/EC_{50}	1
Acute Species	EEC/EC_{05} or NOAEC	1

[1] EEC = lbs a.i./A
[2] EEC = (ppb or ppm) in water

Table 2. Selection of Toxicological Endpoints Used to Determine Risk Quotients (RQs)

Type Of Toxicity	Organism	Species	Toxicological Endpoint
Oral Acute	Bird	Mallard	1040 mg/kg
Dietary		bobwhite/mallard	>5000 ppm
Chronic		bobwhite	500 ppm [1]
Oral Acute	Mammal	Rat	>5000 mg/kg
Chronic		Rat	100 ppm [2]
Acute	Freshwater Fish	Rainbow trout/Bluegill	0.88 ppm
Chronic		Rainbow trout	0.88 ppb [3]
Acute	Freshwater Invertebrates	Daphnid	2.18 ppm
Chronic		Daphnid	0.03 ppm
Acute	Estuarine Fish	Sheepshead Minnow	1.5 ppm
Chronic		Sheepshead Minnow	0.0015 ppm[4]
Acute	Estuarine Invertebrates	Mysid	0.27 ppm
Chronic		Mysid	0.0037 ppm[4]
Acute	Aquatic Plants (vascular)	duckweed	EC50 =41 ppb; NOAEC = <8 ppb
	Aquatic Plants (Nonvascular)	marine diatom	EC50 = 5.2 ppb

[1] No effects on any reproductive parameter or viability of of F_1 offspring at the highest dose tested, 1000 ppm; however due to excessive mortality (33%) of adult female birds in that dose level, a NOAEC for chronic effects was set at 500 ppm.

[2] Based on LOAEL of $\geq$38 mg/kg/ day for inactive mammary tissue and fetal/pup death observed in the one year range-finding test of a rat reproduction study. NOAEC > 100 ppm.

[3] Rainbow trout was more sensitive than the fathead minnow (fathead minnow NOAEC= 33 ppb).

[4] Extrapolation from acute/chronic ratio.

Table 6. Environmental Fate Input Parameters for GENEEC 2.0.

Chemical	Oxadiazon
PC Code	109001
Water Solubility (25°C)	1 ppm
Hydrolysis Half-Life (pH 7)	stable
Aerobic Soil Metabolism Half-Life	stable
Aerobic Aquatic Metabolism Half-life	not available
Photolysis Half-Life	2.75 days
Soil/Water Equilibrium Partition Coefficient (K_d)	16.91
Depth of Incorporation (Broadcast)	0.0 in.
Wetted-In	Yes

Table 7. Modeling Results for Use on Turf

		Ground spray[1]				granular
Application Rate		2.0	3.0	4.0	4.0	4.0
Application Frequency		1	1	1	2	2
Application Interval (days)		N/A	N/A	182	182	182
GENEEC 2.0	Peak EEC	44	67	89	173	150
	21-Day EEC	43	65	87	170	147
	60-Day EEC	42	63	84	163	142

3. Low boom ground sprayer with fine spray quality (EFED defaults), no buffer (no spray zone).

APPENDIX G: ENVIRONMENTAL FATE AND ECOLOGICAL EFFECTS DATA REQUIREMENTS

Table of Data Requirements of Ecological Effects for Oxadiazon

Guideline #		Data Requirement	Is Data Requirement Satisfied?	MRID #'s	Study Classification
71-1	850.2100	Avian Oral LD_{50}	yes	41610101	core
71-2	850.2200	Avian Dietary LC_{50}	yes	41610102 41610103	core core
71-4	850.2300	Avian Reproduction	yes	41993201 41993202	supplemental core
72-1	850.1075	Freshwater Fish LC_{50}	yes	42350601 42330401	core core
72-2	850.1010	Freshwater Invertebrate Acute LC_{50}	yes	41784301	core
72-3(a)	850.1075	Estuarine/Marine Fish LC_{50}	yes	42615801	core
72-3(b)	850.1025	Estuarine/Marine Mollusk EC_{50}	yes	42570301	core
72-3(c)	850.1035 850.1045	Estuarine/Marine Shrimp EC_{50}	yes	42615802	core
72-4(a)	850.1400	Estuarine Fish Early Life-Stage	no		
72-4(b)	850.1300 850.1350	Estuarine/ Marine Invertebrate Life-Cycle	no		
72-5	850.1500	Freshwater Fish Full Life-Cycle	na	-	-
122-1(a)	850.4100	Seed Germ./Seedling Emergence	no	-	-
122-1(b)	850.4150	Vegetative Vigor	no	-	-

122-2	850.4400	Aquatic Plant Growth	yes	41610107 41610108 41610105 41610106 42659001	supplemental core core core supplemental
123-1(a)	850.4225	Seed Germ./Seedling Emergence	no		
123-1(b)	850.4250	Vegetative Vigor	no		
123-2	850.4400	Aquatic Plant Growth	partially [5]	41610105 41610106 41610106 41610108	core
141-1	850.3020	Honey Bee Acute Contact LD_{50}	yes	4268301	core
141-2	850.3030	Honey Bee Residue on Foliage	not required		
70-1		Acute and Chronic Sediment Toxicity Testing	no[6]		
70-1		Aquatic Phototoxicity Studies	no		

[1] Although the mallard study was supplemental since a NOAEC was not established, the study does not have to be repeated; the bobwhite was more sensitive and was used for risk assessment purposes.

[2] Early-life stage fish testing with an estuarine species is required. The raw data for the rainbow trout study MRID 41811601 must be submitted. This information was requested in 1997 under D165510.

[4] The rates used should be low enough to elicit an NOAEC or allow for accurate estimation of the EC05 for all measured parameters. The measured endpoints should include: shoot length, root length and/or height, and a phytotoxic rating of the visible effects. Testing must be conducted with a liquid typical end-use product, rather than technical product, due to the insolubility of the material and since historically, plant species have been found to be more sensitive to the end-use product, than technical. Concentrations must be measured, and results must be based on measured concentrations. The nominal concentrations used in statistical analyses most likely did not represent actual exposure. This information was requested in 1995 under D166982.

[5] A freshwater blue-green algae (Anabaena flos-aquae) is required; the study submitted (MRID 41610104) was invalid.

[6] The high K_{OC} of oxadiazon, combined with the high persistance exhibited in the aerobic soil metabolism, as well as the anaerobic aquatic metabolism (>>10 days) trigger the requirement of a Chronic Sediment Toxicity Testing with both *Hyalella azteca* and *Chironomus tentans*.

Table of Data Requirements of Environmental Effects for Oxadiazon

Guideline #		Data Requirement	Is Data Requirement Satisfied?	MRID #'s	Study Classification
161-1	835.2120	Hydrolysis	Yes	41863603	acceptable
161-2	835.2240	Photodegradation in Water	Yes	41897201	acceptable
161-3	835.2410	Photodegradation on Soil	Yes	41898201	acceptable
161-4	835.2370	Photodegradation in Air	waived[2]	N/A	N/A
162-1	835.4100	Aerobic Soil Metabolism	Yes	42772801	acceptable
162-2	835.4200	Anaerobic Soil Metabolism	Yes[3]	NA	N/A
162-3	835.4400	Anaerobic Aquatic Metabolism	Yes	42773802	supplemental
162-4	835.4300	Aerobic Aquatic Metabolism	No	NA	NA
163-1	835.1240 835.1230	Leaching-Adsorption/Desorption	Yes	44555608, 41898202	acceptable, supplemental
163-2	835.1410	Laboratory Volatility	waived[1]	N/A	N/A
163-3	835.8100	Field Volatility	waived[1]	N/A	N/A
164-1	835.6100	Terrestrial Field Dissipation	Yes	41767401	acceptable
164-2	835.6200	Aquatic Field Dissipation	not required	N/A	N/A
164-3	835.6300	Forestry Dissipation	not required	N/A	N/A

[2] Waived due to the relatively low vapor pressure for oxadiazon (1.00×10^{-6} mm Hg).

[3]Satisfied by submission of an Anaerobic Aquatic Metabolism study.

164-4	835.6400	Combination Products and Tank Mixes Dissipation	not required	N/A	N/A
165-4	850.1730	Accumulation in Fish	Yes	42226701	acceptable
165-5	850.1950	Accumulation- aquatic non-target	not required	N/A	N/A
166-1	835.7100	Ground Water- small prospective	not required	N/A	N/A
201-1	840.1100	Droplet Size Spectrum	reserved	N/A	N/A
202-1	840.1200	Drift Field Evaluation	reserved	N/A	N/A

APPENDIX H: QUALITATIVE USE ASSESSMENT

Case No.: 2485 PC Code:109001

Date: 01-10-01 Analyst: Stephen Smearman

Oxadiazon is a selective preemergence and early post emergence herbicide used primarily to control annual grasses and broadleaf weeds. The tradename for Oxadiazon in the US is *Ronstar* (formerly Chipco Ronstar) and formulations are available as emulsifiable concentrates, granules, flowable and wetable powders.

Based upon the available EPA data and other pesticide usage survey information for Oxadiazon on all sites for the years 1989 through 1999, an annual estimate of Oxadiazon's total usage on all sites averaged 249,000 pounds of active ingredient (a.i.) on an average of 52,000 acres treated over the last 10 years. Most of the acreage is treated with up to 2.4 pounds of a.i. per acre owing most of the usage applies to golf courses which based on reported usage has higher application rates than other uses. Oxadiazon's largest markets in terms of total pounds of active ingredient is allocated to golf courses (65%). The remaining usage is primarily for horticultural/nursery uses and on processed tomatoes (22%). Other reported uses include potatoes and barley which accounts for an respective 1.5% and less than 1% of the total pounds a.i. annually. However, there are no tolerances nor labeled uses for these site and therefore should not be considered during risk assessment. However, there is international reported use of Oxadiazon on rice in China and on cotton in Mexico and Sudan.

Additional estimates of total acres grown and total acres treated for the non-crop sites of road right of ways (ROW), landscape maintenance, horticultural/nursery and park uses are not currently available although there is estimates of pounds of a.i.applied. The following table illustrates the usage of Oxadiazon.

USAGE OF OXADIAZON

Site	Acres Grown (000)	Acres Treated (000)		% of Crop Treated		LB AI Applied (000)		Average Application Rate		
		Wtd Avg	Est Max	Wtd Avg	Est Max	Wtd Avg	Est Max	lb ai/ acre/yr	#appl / yr	lb ai/ A/appl
*Potatoes	1,373	2	4	0%	0%	4	8	2.0	1.0	2.0
*Barley	7,326	0	1	0%	0%	0	1	1.0	1.0	1.0
Lots/Farmsteads/etc	56,000	1	3	0%	0%	1	4	1.3	1.0	1.3
Golf Courses	1,618	49	98	3%	6%	160	235	2.4	1.0	2.4
Landscape Mainten	-	-	-	-	-	12	24	3.0	-	-
Rights of Way	-	-	-	-	-	5	10	-	-	-
Parks	-	-	-	-	-	11	22	-	-	-
Horticultural Nurseries	-	-	-	-	-	56	112	4.0	-	-
Total		51.915	106			249.03	416			

COLUMN HEADINGS

Wtd Avg = Weighted average--the most recent years and more reliable data are weighted more heavily.
Est Max = Estimated maximum, which is estimated from available data.
Average application rates are calculated from the weighted averages.

NOTES ON TABLE DATA

Usage data primarily covers 1988 - 1998. Calculations of the above numbers may not appear to agree because they are displayed as rounded
to the nearest 1000 for acres treated or lb. a.i. (Therefore 0 = < 500)
to the nearest whole percentage point for % of crop treated. (Therefore 0% = < 0.5%)

* = Available EPA sources indicate that usage is observed for potatoes and barley in the reported data for this site. However, there are no tolerances or labeled uses for these site. Reason for reported usage is undetermined and therefore usage for these sites should not be used for risk assessment.

- = missing information or lack of confidence in the data to determine an accurate estimate of usage. However, these sites were included in the table because of indicated
usage.

SOURCES: EPA data, 1988-98; USDA, NASS, 1999

APPENDIX I. GENEEC 2.0 INPUT PARAMETERS, RESULTS, AND OUTPUTS

Environmental Fate Input Parameters for GENEEC 2.0.

Chemical	Oxadiazon
PC Code	109001
Water Solubility (25°C)	1 ppm
Hydrolysis Half-Life (pH 7)	stable
Aerobic Soil Metabolism Half-Life	stable
Aerobic Aquatic Metabolism Half-life	not available
Photolysis Half-Life	2.75 days
Soil/Water Equilibrium Partition Coefficient (K_d)	16.91
Depth of Incorporation (Broadcast)	0.0 in.
Wetted-In	Yes

Table 2. Modeling Results for Use on Turf

		Ground spray[1]				granular
Application Rate		2.0	3.0	4.0	4.0	4.0
Application Frequency		1	1	1	2	2
Application Interval (days)		N/A	N/A	182	182	182
GENEEC 2.0	Peak EEC	44	67	89	173	150
	21-Day EEC	43	65	87	170	147
	60-Day EEC	42	63	84	163	142

4. Low boom ground sprayer with fine spray quality (EFED defaults), no buffer (no spray zone).

RUN No. 1 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
4.000(8.000)	2 182	16.9	1.0	GRHIFI(6.6)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
173.14	172.44	169.50	163.00	158.23

RUN No. 2 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
2.000(4.000)	2 42	16.9	1.0	GRHIFI(6.6)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
88.20	87.84	86.34	83.03	80.60

RUN No. 3 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
3.000(6.000)	2 182	16.9	1.0	GRHIFI(6.6)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
129.85	129.33	127.12	122.25	118.67

RUN No. 4 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
4.000(8.000)	2 182	16.9	1.0	GRANUL(.0)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
150.41	149.80	147.25	141.60	137.46

RUN No. 1 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
2.000(2.000)	1 1	16.9	1.0	GRHIFI(6.6)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
44.39	44.21	43.46	41.79	40.57

RUN No. 1 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
3.000(3.000)	1 1	16.9	1.0	GRHIFI(6.6)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
66.59	66.32	65.19	62.69	60.85

RUN No. 1 FOR Oxadiazon ON Turf * INPUT VALUES *

RATE (#/AC) ONE(MULT)	No.APPS & INTERVAL	SOIL Kd	SOLUBIL (PPM)	APPL TYPE (%DRIFT)	NO-SPRAY (FT)	INCORP (IN)
4.000(4.000)	1 1	16.9	1.0	GRHIFI(6.6)	.0	.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METABOLIC (POND)	COMBINED (POND)
.00	0	N/A	2.75- 341.00	.00	341.00

GENERIC EECs (IN MICROGRAMS/LITER (PPB))

PEAK GEEC	MAX 4 DAY AVG GEEC	MAX 21 DAY AVG GEEC	MAX 60 DAY AVG GEEC	MAX 90 DAY AVG GEEC
88.79	88.43	86.92	83.59	81.14

APPENDIX J. PHOTOXICITY STUDY PROTOCOL for LIGHT-DEPENDENT PEROXIDIZING HERBICIDES

The light-dependent peroxidizing herbicides (LDPHs) are a growing class of weed control chemicals (see partial listing attached). They act in plants by inhibiting the enzyme protoporphyrinogen oxidase (protox), which is the last common enzyme in the heme and chlorophyll biosynthetic pathways.[4] Protox exists in both plants and animals and the enzyme from both sources has been shown to be highly sensitive to many LDPHs.[5]

LDPH protox inhibition in plants results in a rapid accumulation of protoporphyrin IX, a phototoxic heme and chlorophyll precursor. In the presence of light, protoporphyrin IX is a powerful generator of singlet oxygen which in plants causes lipid membrane peroxidation leading to a rapid loss of turgidity and foliar burns. LDPH exposure in mammals has been shown to result in excretion of porphyrins in urine (porphynuria) and feces, increased liver weight, elevated blood porphyrin levels, developmental abnormalities, and cancer. Humans with a hereditary protox disorder (variegate porphyria) which results in lowered protox activity exhibit many symptoms similar to LDPH exposure in addition to photosensitivity. However, photosensitivity is not a commonly reported symptom of LDPH exposure in animals.

An LDPH-induced occurrence of phototoxicity in rats[6] and increased cytotoxicity to human skin cells grown in culture in the presence of light and an LDPH[7] have been reported but many other LDPH toxicity studies make no mention of phototoxicity in animals. The scarcity of phototoxicity data in animals could result from physiological or biochemical distinctions from plants. For instance, animals exposed to LDPHs may not normally accumulate protoporphyrin IX in their epidermis. However, phototoxicity may not be reported in many LDPH toxicity tests because of relatively low light conditions in laboratories and/or protection afforded by the animals' fur or feathers. Animals without fur or feathers existing in sunny environments would be expected to be at highest risk for potential phototoxic effects.

The Aquatic Biology Tech Team (ABTT) recommends that phototoxicity studies be conducted on herbicides with this mode of action to determine if animals exposed to LDPHs and intense light (similar to sunlight) show increased toxicity relative to controls exposed to LDPHs and low intensity light. The results of these studies will help to determine if animals that are exposed to sunlight in LDPH use areas are at higher risk than guideline toxicity studies suggest.

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[4]Matringe, M., J.-M. Camadro, P. Labbe, and R. Scalla. 1989. Protoporphyrinogen oxidase as a molecular target for diphenyl ether herbicides. *Biochem. J.* **260**: 231-235.

[5]Birchfield, N.B., and J.E. Casida. 1997. Protoporphyrinogen oxidase of mouse and maize: Target site selectivity and thiol effects on peroxidizing herbicide action. *Pesticide Biochemistry and Physiology* **57**, 36-43.

[6]Halling, B.P., D.A. Yuhas, V.F. Fingar, and J.W. Winkleman. 1994. "Protoporphyrinogen oxidase inhibitors for tumor therapy" in *Porphyric Pesticides: Chemistry, Toxicology, and Pharmaceutical Applications*, (S.O. Duke and C.A. Rebeiz, Eds.) pp. 280-290, American Chemical Society Symposium Series 559, Am. Chem. Soc., Washington, D.C., 1994.

[7]Birchfield, N.B. *Protoporphyrinogen Oxidase as a Herbicide Target: Characterization of the [^{3}H]Desmethylflumipropyn Sorbing Site*. Dissertation. University of California, Berkeley. 1996.

The ABTT is requesting that a LDPH phototoxicity protocol be submitted for review and agreement by EFED and the registrant prior to study initiation. Protocols for standard toxicity tests have also been published.[8] In nature, fish and other aquatic organisms are expected to be exposed to LDPHs through run-off and spray drift. Aquatic organisms inhabiting small, shallow water bodies, exposed to high levels of solar radiation would be expected to be at greatest risk for potential phototoxic effects. Therefore, the ABTT is requesting a small fish species be used in a phototoxicity assay to assess the potential of light to increase LDPH toxicity.

The ABTT requests that the study adequately address the following issues and suggests the paper, "Photoenhanced Toxicity of a Carbamate Insecticide to Early Life Stage Anuran Amphibians",[5] and other studies in the peer-reviewed scientific literature serve as sources of additional guidance:

Species
The fathead minnow may be an appropriate test species because of existing toxicity protocols which may be adapted for this study.

Exposure duration
A subchronic exposure duration would be adequate for proof of principle. A single exposure may not allow adequate time for porphyrin accumulation, however, a life-cycle is not necessary to identify a phototoxic effect.

Dosing
A range finding study should be conducted under defined low light conditions to identify an LC_{50} value and lower dose levels expected to be similar to controls. Doses used in the phototoxicity study should not be expected to result in significant mortality in low light controls. Dissolved concentrations of the test chemical should be confirmed by an appropriate analytical method.

Endpoints
Behavioral observations should be made in addition to measurements of mortality, growth, weight, morphology, and appearance. Ideally, measurements of protoporphyrin and heme concentrations in the blood and protox activity in the liver of each test organisms should be made.

Light sources
Artificial light may be preferred to natural light that will vary in different regions and seasons as well as with weather. If artificial light is used, the light should resemble full, natural sunlight as closely as possible, particularly around 400 nm. The most important wavelength for porphyrin induced phototoxicity in ~400 nm. No matter what the light source, the duration and intensity of UV and visible light should be reported at all wavelengths (200-800 nm). At this point EFED does not have a specific recommendation for an artificial light source.

Dark, light, and positive controls
As this study is intended to identify potential effects of light on LDPH toxicity, an appropriate study protocol should

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[8]American Society for Testing and Materials. 1994. Standard guide for conducting the frog embryo teratogenesis assay-*Xenopus*. E 1439-91. In *Annual Book of ASTM Standards*, Vol 11.5, pp. 825-835. Philadelphia, PA.

include a dark, or low light, control group. Another group not exposed to chemicals but exposed to full light should be included (a full light control). In addition to the dark and light controls, a positive control group using protoporphyrin IX may be useful.

Exposure chambers and light filters

Light intensity should be measured inside test chambers if glass or any other material is placed between the light source and the test animals. Any filters should be cured under the study light for 72-hours prior to study initiation to ensure consistent transmittance.

ATTACHMENT 1.

The following list of herbicides are believed to act by inhibiting protoporphyringen oxidase in the heme and chlorophyll biosynthetic pathway.

acifluorfen
azafenidin
carfentrazone-ethyl
flumiclorac-pentyl
flumioxazin
fluthiacet-methyl
fomesafen
lactofen
oxadiargyl
oxadiazon
oxyfluorfen
sulfentrazone
thidiazimin